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SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE
VOLUME 35, NUMBER 3

A CONTRIBUTION TO THE COMPARATIVE HISTOLOGY OF THE FEMUR

BY

J. S. FOOTE, M. D.
Professor of Pathology, Creighton Medical College, Omaha, Nebraska

EDITED BY ALEŠ HRDLIČKA

(No. 2382)

CITY OF WASHINGTON
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Commission to whom this memoir
has been referred:

Aleš Hrdlička
Frank Baker
George Arthur Piersol

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ADVERTISEMENT

The present memoir by J. S. Foote, M. D., Professor of Pathology at Creighton Medical College, entitled "A Contribution to the Comparative Histology of the Femur," records original observations begun by the author in 1909 in a study of cross-sections of the femora of about six hundred different animals, including amphibians, reptiles, birds, mammals, and man, with a view to determine what variations of bone structure may exist and their signification.

In accordance with the rule adopted by the Smithsonian Institution, the work has been submitted for examination to a commission consisting of Dr. Aleš Hrdlička, of the United States National Museum; Dr. Frank Baker, of the National Zoological Park; and Dr. George Arthur Piersol, of the University of Pennsylvania, who recommended its publication in the present series.

The work is published in cooperation with the Creighton University, Omaha, Nebraska.

Charles D. Walcott,
Secretary.

Smithsonian Institution,
Washington, *December, 1915.*

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ACKNOWLEDGMENT

This work has been largely of a pioneer nature. The zoological classification of animals has furnished the principal guide in the selection of bones and in the general plan of study. Beginning with the amphibians and closing with man, one femur after another has been examined until sufficient data have been accumulated to establish, to a reasonable degree, definite bone types and type combinations which were then employed as a structural basis for comparative study.

In an investigation of this character, covering a period of more than five years and involving many details, it will not be surprising if imperfections are found; but all possible effort was made to eliminate those that could be detected.

The study has brought to light a number of important new facts. Among other conclusions the author finds that three types of minute structure form the basis of all bones. The first and second types predominate in amphibians, reptiles, and birds, the third in mammals and man. The first type, composed of lamellæ, appears as a uniform structure or in a twofold or threefold division, and characterizes the amphibians, lizards, and bats. The second type (laminar) appears first in the amphibians and in an early or late form of differentiation in birds and lower mammals. The third type (Haversian system) is first outlined in the amphibians and reaches its highest development in the higher mammals and especially in man.

For valuable material, facilities for study and courtesies extended, the writer is especially indebted to the Division of Physical Anthropology of the United States National Museum, to the Divisions of Mammals and Reptiles of the same institution, to the Departments of Reptiles, Birds, and Mammals of the American Museum of Natural History, to the Nebraska State Hospital, and to the Departments of Anatomy of the Northwestern, the Tulane, the Nebraska, and Creighton Universities.

Furthermore, he desires to express his deep sense of obligation to those who have assisted him: to Dr. Aleš Hrdlička for his encouraging interest and most valuable suggestions in the pursuance of the study, without his clearing-house advice the tedious details would have fallen into a useless mass; to Creighton University for apparatus and material assistance in the publication of this report; to Professor William F. Rigge for the calculation of the medullary indices; and to the many students and friends who have rendered assistance in every possible manner.

J. S. Foote.

A CONTRIBUTION TO THE COMPARATIVE HISTOLOGY OF THE FEMUR

By J. S. FOOTE, M. D.

I. INTRODUCTION

The investigations in the Comparative Histology of the Femur were begun by the writer in 1909, and were suggested by a section of the turkey's femur which he had casually prepared and which seemed to show a type of bone structure quite unlike that usually described. Before long, other peculiarities were noticed and it was then decided to extend the study to various animals for the purpose of determining what variations of bone structure may exist, and, if possible, what is their significance. Accordingly, the femora of 46 different animals, including amphibians, reptiles, birds, mammals, and man, were examined as they could be obtained and described, the report being published in the Transactions of the American Miscroscopical Society of April, 1911.[1] The number of femora examined up to that time was small, nevertheless the results of the work were so new and interesting as to warrant further study.

Following the report and upon the suggestion of Dr. Aleš Hrdlička, curator of the Division of Physical Anthropology in the United States National Museum, the writer extended his investigations to a much greater number of orders, genera, and species of the lower animals, and finally also to the three main races of man—black, yellow-brown, and white—the latter including the ancient Egyptian. An abstract of the results of the advanced investigations was published in 1913 by the Smithsonian Institution.[2] The studies, however, were still continued as long as material was available and finally have been combined in this memoir which presents a comprehensive view of the whole work thus far accomplished. In all, 600 sections have been examined; of these 440 are described.

The present report includes, besides the text, 467 drawings. They were made, for the most part, directly from the slides with the help of the Edinger Drawing Apparatus, and are illustrations of the structural bone units, of the types and combinations of bone types in their various stages of differentiation,

[1] Foote, J. S. The comparative histology of femoral bones. Trans. Amer. Micros. Soc., 30, 1911, pp. 87-140, 9 plates.

[2] Foote, J. S. The comparative histology of the femur. Smithsonian Miscellaneous Collections, Vol. 61, No. 8 (Publication 2232), Washington, 1913, pp. 1-9, 3 plates.

and of the arrangements of types as they would appear in reconstructed femora. The exact number of histologic bone units of any section does not, and obviously could not, appear in the drawings. The writer's endeavor has been to represent, in a comprehensive way, the development, proportions, and arrangements of these units, rather than their exact number.

It was also found impracticable to make the drawings of the various bone sections to a definite, uniform scale, the femora ranging from 0.5 mm. to 13 cm. in diameter. Microphotographs were essayed, but were found unsatisfactory.

The various diameters of the examined femora, their medullary canals, and medullary indices are given in the synoptic tables and also in the text at the beginning of each detailed description. The sections and measurements were made invariably at the middle of the shaft of the bone.

The femur was selected for these studies rather than any other bone of the body, because it is of good size, because it is in fairly constant use, and on account of its being the sole bone of an important segment of the body. It is, in other words, a good representative bone and perhaps the best adapted to the investigations of this nature.

The illustrations have, generally, been grouped according to the structural relations of the bones.

The type or combination of types of structure which any bone was observed to present will be found noted in the tables, so that by a glance at these there may be readily obtained a comprehensive view of the grouping of the femora of the various animals.

The femora examined and included in this report are those of amphibians, reptiles, birds, mammals, and man. Fetal, young, adolescent, adult, and senile femora of the same species were examined whenever possible, and, when circumstances allowed, observations were also made on other bones of the body. All sections were carefully ground to proper thinness and mounted in hard balsam.

II. SUMMARY OF RESULTS

As the mass of detailed observations which follow will be consulted in special instances only, it may be convenient to the reader to have a general summary of the principal results of the study presented at this place instead of at the end of the work.

The microscopic structure of a long bone described by the early histologists happened to be that of a third or Haversian system type, and it has been assumed, perhaps without a more definite reason, that all long bones have the same structure. From an examination of a large number of femora it is evident that they have not.

If there is any one distinctive characteristic of bone structure shown by the present investigation, it is that of extensive variation, variation due to heredity, to age, size and strength of the bone, and possibly to other conditions. It is certainly safe to say that few long bones, and particularly femora, have precisely the same structure, and yet, through all their diversity, there can be perceived certain definite, readily recognizable strains, which are found not only peculiar to separate groups of animals, but also to definite stages of differentiation.

The summary which follows will be treated under the following headings:

General shape.

Relation of structure to shape.

Density of bone.

Measurements.

Medullary index.

Medullary canal.

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Medullary surface.

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General Shape of the Femora of the Lower Animals

By the shape of the femur is understood the shape of the cross-section of the bone at its middle. That this shape of the shaft of the femur varied considerably in man was long since shown by Hrdlička.[1] The present studies demonstrate that it differs also in animals. In general it is represented by the same geometrical types as in man, being triangular, elliptical, round, quadrangular, and plano-convex. Also, as in man, besides the femora which are fairly true to a type, there are others which are irregular or indeterminate in shape and do not admit of any definite classification.

Generally speaking, however, there was one particular shape which was more prominent than any other, and that was the elliptical. This was found to be true of the majority of adults among amphibians, reptiles, birds, bats, and other mammals, and, therefore, was the most common shape of femur below man as far as these examinations were concerned. The differences in the lengths of the two main diameters were usually small, the lateral diameter being generally the longest; in only a few specimens—as in the femur of the seal—were the lateral diameters greatly in excess of the antero-posterior. The femora of the *Hyla cinerea, Erinaceus europeus, Tatu novemcinctus, Castor canadensis,* and *Rhinoceros bicornis* had very long posterior, lateral, curved or straight ridges and differed very materially from other femora. The variations from the circular and elliptical shapes were in a measure dependent upon the development of the linea aspera. In some femora this was absent; in others it was fairly well developed; and in still others its development was extreme. In the table which follows will be found the various shapes of the femora of the lower animals expressed in percentages:

SHAPE OF THE SHAFT OF THE LOWER ANIMAL FEMUR AT THE MIDDLE

	No. of femora examined	I Triangular	II Elliptical	III Round	IV Quadrangular	V Indeterminate	VI Plano-Convex
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Amphibians	39	26	41	28	0	5	0
Reptiles	34	29	53	9	3	0	6
Birds	40	12	52	18	3	0	15
Bats	55	0	72	25	0	0	3
Other Mammals	133	21	53	15	0	5	6
Totals	301	17	50	25	0.7	3	5

Relation of Structure to Shape

As far as present investigations are concerned, no special relation of the histologic structure of the femur to the shape of its shaft has been determined. The prolonged posterior ridge of the triangular sections is due to the linea aspera, and wherever the latter is well developed macroscopically it is composed of Haversian systems regardless of the type of the rest of the bone.

As will be seen later, the linea aspera seems to have a development quite distinct from the rest of the femur.

[1] See in this connection, Hrdlička, A.—Typical forms of shaft of long bones. Proc. Amer. Assoc. Anatomists, 14th Sess., 1900 (Washington, 1901), pp. 55-69.

Density of Bone

This quality of bone was estimated by its weight and the subjective feeling experienced during the process of grinding, and was found to be far from uniform. Hardly any two bones were the same in this respect. Some were heavy and others were light; some were hard and others were soft. In some, one portion of the wall was hard and another was soft, and in still others there were soft and hard spots. The femur of the hippopotamus was extremely heavy and exhibited a stone-like quality in grinding, while that of the peahen, turkey-buzzard, or eagle was light and had a flint-like character. Many mammalian and human femora were found to vary greatly in the densities of the different portions of their wall. The outer was soft and the inner hard, or vice versa. This was noticed more especially in human femora. Many human bones also had small areas of unequal hardness which were sometimes accounted for by senile changes. Finally, sections of some femora—as those of the elk—seemed to show an extremely brittle character.

In some cases these inequalities could be explained by histological variations; while in others the chemical character of the inorganic compound seemed to govern the hardness. As a rule, first and second type bones (lamellar and laminar) ground more easily than third (Haversian system), as might be expected. But the femur of the peahen had flinty hardness and yet showed an incomplete second type of structure. This could only be explained by some peculiarity of its inorganic composition.

Measurements

The following measurements of each cross-section were taken: the antero-posterior and lateral diameters of the bone and the same diameters of the medullary canal. All measurements were recorded in millimeters. The results will be found in the synoptic tables and also at the beginning of each detailed description. The measurements will give a correct impression of the relative diameters of the shafts of the various femora, and upon them are based the calculated ratios of the medullary canals to their respective bones.

Medullary Index

The ratio of the square of the mean diameter of the medullary canal to that of the surrounding bone, as determined from cross-sections of the middle portions of the various femora, is referred to as the medullary index. It has been calculated from the formula below.[1] The individual indices will be found

[1] $$\left(\frac{\left(\frac{a+b}{2}\right)^2\times 100}{\left(\frac{A+B}{2}\right)^2-\left(\frac{a+b}{2}\right)^2}\right)=R.$$

a and b are the long and short diameters of the medullary canal respectively. A and B are the long and short diameters of the bone respectively. R is the ratio of the medullary canal to the bone.

The calculations were made by William F. Rigge, S. J., Professor of Astronomy, Creighton University, Omaha, Nebraska.

in percentages in the synoptic tables and text. By an examination of these indices it will be seen that the medullary canals of the various femora do not bear a constant relation to the bones, but present very important variations. In some bones the canals are relatively large and in others they are relatively small. The larger the canal in a given species the thinner the wall of bone, and vice versa. There are also some individual variations within each species, and quite noticeable differences in this respect between the young, adult, and senile bones.

The averages given below show that the medullary indices of the different classes of animals and even in man vary considerably:

		Per cent
Amphibians		36.6
Reptiles (including turtles)		26.1
Reptiles (excluding turtles)		33.0
Birds		159.0
Bats		48.6
Other mammals		63.3
Man	Black race	41.9
	Yellow-brown race	43.8
	Ancient Egyptian	39.5
	Modern white race	35.8
Human race as a whole		38.6

Looking over the above averages it will be noticed:

First.—That the lowest index is found in the reptiles where it is 26.1%. The average index of the class of reptiles is lowered by the turtles, in most of which the index is zero. In the turtle femora the medullary canals are occupied by heavy cancellous bone with very small meshes filled with marrow. Observed with the naked eye these bones appear to be solid. If the turtles are excluded the average reptile index is 33% instead of 26.1%. As far as the medullary canals are concerned, both in regard to their contents and indices, those of the turtles do not resemble those of other reptilian genera in any respect. Comparing the indices of the amphibians with those of the reptiles, it will be seen that the index falls quite sharply or that the medullary canal diminishes and the mass of bone increases markedly from amphibian to reptile.

The highest average index is found in birds, where it is 159%. From this it will be seen that the medullary canal increases relatively in size and the bone decreases in mass enormously from reptile to bird. In proportion to their weight, the birds have less bone than amphibians or reptiles. The index is higher in those birds which have empty medullary canals (226.4%) than in those which have full canals (149.7%). That is, the femora with empty canals have thinner walls in relation to the size of the bone than those with full canals.

Second.—The mean index falls, to a marked degree, from birds to mammals, or from 159% to 63.3%. The index in bats is 48.6%, and in mammals without the bats 63.3%. That is, the canal is smaller and the walls of the bone are thicker in mammals than in birds, and the canal is smaller and the walls are thicker in bats than in other mammals.

Third.—The medullary index in the human race, as a whole, is 38.6% and, therefore, much lower than in other mammals, in which it averages 63.3%; that is, the medullary canal is relatively smaller and the wall of the bone thicker in bipeds which carry the weight of the body on two legs than in quadrupeds which carry the weight on four. The three races, however, show slight variations. In all, 139 human femora were examined—34 black, 23 Indian (pre-Columbian), 9 ancient Egyptian, and 73 modern white. Their respective indices were 41.9%, 43.8%, 39.5%, and 35.8%. From these it will be seen that the index is higher in the ancient than in the modern white femora (counting the Egyptian as of white race), and lower in the modern white (35.8%) than in the modern black (41.9%) or the pre-Columbian Indian (43.8%). That is, the canal is larger and the mass of bone smaller in ancient (Egyptian) than in the modern white femur, and the canal is relatively smaller and the bone larger in the modern white than in the modern black race or the pre-Columbian Indian. The smallest canal and thickest wall were found in the modern white, and the relatively largest canal and thinnest wall in the Indian. Some of these detailed differences may, of course, be purely accidental, due to the insufficient number of specimens, or other conditions; but they are of sufficient interest to warrant further observations.

Medullary Canal

The canal presents many peculiarities in position, shape, size, surface, and contents.

In some femora it is situated eccentrically. This is more especially true of human fetal bones, where the canal occupies the anterior half of the cross-section. It is also true in many adult femora of the triangular shape and third (or Haversian) type. In femora of the first type of structure (the lamellar), the canal is situated almost centrally, as such femora do not often have a well-defined linea aspera. In still other cases it is situated obliquely, as in some human femora.

The shape of the canal seldom corresponds with the peripheral outline of the bone, and the wall of the femur, therefore, is not of uniform thickness excepting in round bones with central canals, and these are generally limited to small femora, to those of the young, and to simple types. In adult bones, the canal varies considerably in shape. In some bones it is nearly circular with fairly regular outlines, as may be seen in the small first type (lamellar) femora like those of the bats. In others it is elliptical or irregular, regardless of the shape of the bone, as in some human specimens.

In size the canal presents several peculiarities. Some femora have relatively very small, and others very large canals. In some cases it is reduced to extremely small dimensions, as in the amblystoma, turtles, yellow-hammer, and some embryonic mammals. It reaches its greatest relative size in birds and its smallest in amphibians and reptiles.

Medullary Contents

The contents vary. Some medullary canals are full of marrow, as those of amphibians, of reptiles, and of bats; some contain cancellous bone and marrow, as those of man; some have trabeculæ, as those of the peahen, eagle, and turkey-buzzard. In birds an important variation is found. About one-half of their femora have canals full of marrow, while the remaining half are either empty or contain trabeculæ only. The full or empty condition of the canal seems to bear no relation to the flight of the bird. The peahen is a poor flier and has an empty canal, and the eagle is a good flier and has an empty canal. The wild goose is a good flier and has a full canal, and the domestic turkey[1] is a poor flier and has a full canal. The peahen and domestic turkey may be thought to exhibit the flying habits of domestication; but these birds show two opposite conditions of medullary contents—the peahen has an empty canal and the turkey a full canal. Similar results are also observed in the wild and domestic turkeys. Both have full canals although they differ greatly in their abilities to fly. Again, in some birds, as the yellow-hammer, pigeon, and white pelican, the medullary canals are occupied by a heavy cancellous bone with small meshes and present the appearances of nearly solid bones, and yet these birds are good fliers. Generally speaking, the medullary canals of amphibians, reptiles, mammals, and man are full, while those of the birds examined are about equally divided. In most cases the canals were filled with yellow narrow. A few, however, were full of red marrow.

Medullary Surface

The medullary canals present a variety of surface. In some instances, as in the peacock and eagle, there is seen extending inward from the wall of the femur an intricate network of trabeculæ, which increases in complexity toward the epiphyses. The surfaces in the larger mammals and in man are generally irregular, from the presence of ridge-like projections.

In many instances the medullary surface is smooth, as in the whole class of amphibians, in lizards, and in bats; while in other cases it is rough, uneven, or irregularly corrugated. This is especially true of the larger mammalian femora.

[1] The humerus has an empty canal crossed by trabeculæ.

Cancellous Bone and Trabeculæ

Cancellous bone is a special form of first type bone characterized by an arrangement of lamellæ enclosing more or less irregularly shaped meshes filled with marrow. The character of the framework varies in the different femora. In some, as in the turtle, it forms a thick, heavy framework with very small meshes (pl. 4, fig. 67). In others, as in some birds, mammals, and in man, it is found as a delicate interwoven lacework with large meshes. In fetal human femora and in the bone of repair there is a channeled bone substance in which irregularly shaped meshes are present.

Cancellous bone, filling the medullary canal, has a wide distribution in the femora of animals. It is found in all classes from amphibian to man, but does not occur in the majority of the species. It was present in only one amphibian, absent in the lizards, present in the turtles, present in a few birds—yellow-hammer, pelican, and domestic pigeon—in many mammals, and in nearly all human femora. It was not found in the order of bats.

Trabeculæ.—Bone trabeculæ are composed of a few lamellæ with long narrow lacunæ and branching canaliculi, with or without Haversian systems.

In those bones which have marrowless medullary canals, trabeculæ form an interlacing network, as in the peahen and turkey-buzzard. The trabeculæ extend transversely from wall to wall, or more or less up and down toward the epiphyses of the bone. Near the extremities they generally form a labyrinth, as in man. The femora having trabeculæ are generally thin-walled.

The medullary canals which do not contain marrow have networks of trabeculæ, while those with marrow have cancellous bone or not, according to the animal.

Trabeculæ are very infrequent in amphibians, reptiles, mammals, or man, and reach their greatest degree of frequency in birds.

Variety of Minute Structure of the Wall of the Femur

We may now approach the minute structure of the wall of the femur. There is no one type of structure which characterizes all the femora of any single species of animal. Some individuals in each species will show single, pure-type bones, while others, and these are generally in the majority, present combinations of types. A great variety of combinations occurs. All bones consist of the same fundamental structural units, but these are combined and arranged in many ways and in different proportions. Three pure types and several combinations of types, in some stage of differentiation, are more clearly distinguishable and will be defined below.

The Units of Bone Structure

The units of bone structure are divisible into the basic and the differentiated. The basic units are the bone substance proper and in a measure also the individual bone cell with its dendrites or the lacuna with its canaliculi. The differentiated units are the lamella, the lamina, and the Haversian system.

But little needs to be said in this place about the basic units. The bone substance behaves passively and is wholly subject to the activity of the cells. While the cells with their processes are the all-important, living, constructive, and destructive parts of the bone, they change and act in ways that are, as yet, largely obscure. Certain modifications in their characteristics have, however, been observed in the course of the present work and will be mentioned in the proper place.

Bone Cells—Lacunæ

Bone cells or osteocytes have formed, and in fresh bone occupy the small spaces called lacunæ. The latter vary in shape from round and oval to long and narrow. Many femora have both. The round lacunæ characterize especially the young bone, while the long prevail in bone which is fully formed. The denser the bone, the more probability there is that it will present the long, narrow lacunæ, while in the rarer, but not senile bone substance, the round and oval forms are more abundant (pl. A, figs. A, B, C).

Dendrites and Canaliculi

The dendrites are processes which extend outwardly from the bone cells, the canaliculi being minute canals in the bone substance for the accommodation of the dendrites. In a cross-section of the femur, the exposed canaliculi are seen to vary considerably. In some cases they are short, branching, and bushy in appearance, while in others they are long and but slightly branched. The former belong to the round or oval, the latter to the long and narrow lacunæ (pl. A, figs. A, B, C).

Differentiated Bone Units—Lamellæ

Although bone first appears as a basic or undifferentiated substance in very young embryos and possibly in the more primitive forms of the lower classes of animals, in the course of time it manifests a tendency towards differentiation. Perhaps the earliest sign of such tendency is indicated by the concentricity of the lacunæ and next by the formation of what are known to the histologist as lamellæ (pl. A, fig. F).

A lamella can, at present, only be defined as a simple, separate layer of bone. The exact mode of its formation is not as yet known, but it must, of course, be the product of the progressive activity of the bone-forming elements. The lamellæ themselves follow several lines of differentiation. Three distinct forms may be distinguished. They are as follows:

UNIFORMLY LAMELLATED BONE

Bones of this character, after their development has reached its limits, are composed entirely of concentric lamellæ. The structure is uniform in all parts of the section. The lacunæ are oval or long and narrow (pl. A, fig. E; pl. 2, fig. 7).

TWOFOLD DIVISION

A further stage of differentiation is found in many femora in which a twofold division has occurred; that is, the section is composed of wide external and very narrow internal lamellar rings in contact with each other (pl. 2, fig. 9).

THREEFOLD DIVISION

In some femora the lamellæ are separated into three concentric rings. The external ring is narrow, the central wide, and the internal again narrow (pl. 2, fig. 27).

Lamellæ appear as the most prominent structures in amphibians, reptiles, bats, and in early fetal human femora.

Laminæ

The lamina, as used in this memoir, is a larger and more complex bone layer than the lamella. It is composed of a variable number of concentric sheaths of lamellæ surrounding the bone or its medullary canal, but the characteristic feature is that it is separated from adjacent structures by systems or plexuses of vascular canals extending in a direction parallel with the medullary and external surfaces of the bones. It occurs in birds, mammals, late fetal, and early childhood, and is often, though not invariably, a stage in the differentiation of bone from the first to the third. It reaches its highest degree of development in mammals (pl. A, fig. J; pl. B, figs. 2, 5).

Haversian Systems

The Haversian systems are more or less cylindrical shaped complexes of varying diameters composed of concentric lamellæ enclosing a central or Haversian canal. They extend in a direction parallel with the long axis of the bone, and in sections cut at right angles are circular in outline. In many cases, however, and perhaps in the majority, their directions are considerably modified and instead of extending in directions parallel with the long axis they run tortuous courses (pl. A, fig. F; pl. B, figs. 3, 6).

Haversian systems, foreshadowed in a few amphibians, somewhat advanced in some reptiles and birds, much more completely differentiated in the lower mammals, become fully developed in man.

Types of Bone Structure

The most interesting and unexpected fact which has been brought out by the investigations herein reported is the existence, in the femur as well as in other bones of the body, of three distinct, easily separable types of minute bone structure, corresponding, respectively, to the lamellar, laminar, and Haversian system stages of differentiation. These may occur alone, but are very frequently found in various though in general readily analyzable combinations.

The types may be called the primary, intermediate, and advanced; or simply the lamellar, laminar, and Haversian system types. More conveniently than either, perhaps, they may be designated as the first, second, and third types respectively. They are shown in plate A, figures 1, 2, 3; plate B, figures 1, 2, 3; microscopically and grossly in plate B, figures 4, 5, 6.

These types of bone structure are, in the main, nothing but various stages of osseous development. They do not represent radically distinct varieties of bone, but rather consecutive stages of differentiation of one and the same fundamental variety which underlies bone structure in all the terrestrial vertebrates. The bone structure advances from simple to more complex in conformity with definite laws which affect all the organisms possessing a skeleton, and the process is never reversed. The main types of bone structure that were determined may be defined briefly, as follows:

THE FIRST TYPE

This is composed of basic, or but moderately differentiated, bone substance, enclosing more or less numerous lacunæ, from which radiate scant to numerous minute canaliculi. The lacunæ are generally round or oval in shape, and their canaliculi are mostly short and bushy. The lacunæ may or may not occupy a definitely concentric position (pl. A, fig. D). In the more advanced stage the lacunæ assume a concentric arrangement, change in shape to a longer and narrower form, their canaliculi become longer and straighter, and the basic bone substance becomes separable into parallel layers, which are the lamellæ. Here development in many species stops (pl. A, figs. E, F). The first type of bone, therefore, is one varying from wholly basic, unorganized bone substance with no perceivable systematic arrangement of the cells, to that showing distinct lamellation with varying lacunæ and canaliculi. The most advanced and characteristic bone unit is the lamella (pl. A, fig. F; pl. B, figs. 1, 4).

The arrangement of the lamellæ is mostly concentric about a larger or smaller canal (pl. A, fig. E), but in some localities in a bone—as in the areas among the Haversian systems—the lamellæ are fragmentary-like and short, and may be straight or curved. On cross-section the individual lamellæ are seen to be, generally, of uniform thickness. Their ventral and dorsal surfaces, on the whole, are regularly shaped, and the edges of the cross-sections are finely serrated. The separate lamellæ are joined by cement. They may constitute the whole bone structure in a given specimen (pl. A, fig. E), or only a part of it; they may surround the Haversian canal and form the basis of the Haversian system, being then known as Haversian lamellæ (pl. A, fig. F); they may enclose the whole medullary canal, in which case they are known as internal circumferential lamellæ; or, finally, they may form the external boundary of the bone, where they are known as external circumferential lamellæ. The lamella, therefore, may be considered as the primary differentiated unit of bone structure—the first to appear in progressive development. Bone cells, represented by lacunæ, may occur within the lamellæ or between them (pl. A, fig. F; pl. B, figs. 1, 4).

It is interesting to notice that the first type bone unit (lamella) is found, in some form, in all femora from amphibians to man, and, as already pointed out, it may vary in its degree of differentiation. According to such differentiation, the lamellæ may become the foundation of the second and third type bones. The differentiation gives rise to three subtypes of lamellated bone: *The uniformly lamellated,* found in many of the amphibians, reptiles, birds, and bats, but not in the higher mammals or man[1] (pl. 2, fig. 7); *the twofold,* which was seen in amphibians, reptiles, birds, bats, and in a few mammals, but not in adult man (pl. 2, fig. 9); and *the threefold,* which occurs in amphibians, reptiles, birds, and bats, but not in the higher mammals or man (pl. 2, fig. 27).

The principal interest in these secondary differentiations of a first type bone lies in the fact that they indicate the manner of origin of divisions which are so frequently present in the higher and later third type or Haversian system bones. In these the outer and inner lamellar rings are known as the external circumferential and internal circumferential lamellæ, while the central broad ring has differentiated into Haversian systems. In some stage of differentiation, the first type bone is found in all femora as an important structure, and, therefore, may be considered as universal.

THE SECOND TYPE

This is composed of laminæ in some stage of differentiation, arranged concentrically around the medullary canal. While Haversian systems may be present here and there, the laminæ dominate and characterize the bone structure. The degree of differentiation present varies. In some cases it is only a

[1] Of the total 440 femora examined, 19 per cent were composed entirely of uniformly lamellated bone and were limited to amphibians, reptiles, and bats. (See table, p. 17.)

little in advance of the lamellar type; in others the advancement is more pronounced; while in still others the type appears to have reached its limits of development (pl. A, figs. H, I, J; pl. B, figs. 2, 5).

The exact mode of development of the lamina, as in the case of the lamella, has not yet been traced. Laminæ show incomplete and complete stages of differentiation.

Incomplete: In some cases, as in birds, basic bone substance is partially separated into indistinct laminæ by a few, short, vascular canals having general concentric positions. The lacunæ are round or oval and the canaliculi are short and bushy and rather infrequent (pl. A, fig. H). In other cases the concentric canals are lengthened and arranged in the form of a more or less complete plexus, in the elongated meshes of which laminæ are more clearly seen. The lacunæ are oval and the canaliculi are very numerous and reticular in arrangement (pl. A, figs. I or 2).

Complete: In still other cases the vascular canals form more or less complete circuits, and the laminæ are well defined in clearly differentiated sheaths, with completely developed lamellæ and long lacunæ with straight canaliculi, and are pierced quite regularly by vascular canals extending transversely (pl. A, fig. J; pl. B, figs. 2, 5).

The laminæ have more individuality than the lamellæ, and in a dried femur of the second type they can be scaled off one after another. They are fairly uniform in thickness, but in the incomplete stage vary considerably in the length of their segments. The laminæ were first observed in two amphibians, occurring singly in the femora of the *Bufo americana* and *Hyla gratiosa* (pl. 2, fig. 14; pl. 3, fig. 36). In both of these bones they were only fairly well developed and occupied irregular positions in reference to the medullary and external surfaces. In the alligator and some turtles they alternated with concentric rings of crude Haversian systems. But it is in birds that laminæ first become prominent as units of bone structure. In these animals the structure of the femora examined presented stages of differentiation varying from a very incomplete to an advanced, but not complete, character. It is not until the laminæ reach the class of mammals that they show their highest development, so that in birds they appear to occupy a transitional position. In fact it is not difficult to distinguish between these units of the bird and the mammal by the incomplete character of the concentric canals and the early differentiations of the lacunæ which are present in birds, and the complete concentric canals and higher grade lacunar differentiations which are present in mammals.

THE THIRD TYPE

This type is composed of Haversian systems as the main units of structure. These systems form the whole bone or a larger proportion of the same. Narrow external and internal sheaths of circumferential lamellæ often surround the bone and its medullary cavity, but the characteristic structural units are the Haversian systems. The type presents two stages of differentiation—the incomplete (I) (pl. A, figs. K, L, M), and the complete (C) (pl. A, figs. N or 3; pl. B, figs. 3, 6). The incomplete differentiation is further divisible into three sub-stages which are indicated in the synoptic tables and text as the Ia, Ib, and Ic stages (pl. A, figs. K, L, M). These stages can be readily distinguished microscopically, and may all occur in a single bone. As a matter of fact, it is often impossible to include all Haversian systems of a bone under any one stage of differentiation. Term (Ia) signifies early, (Ib) intermediate, and (Ic) the late stage of incomplete differentiation. When the process of differentiation is completed, the Haversian system is referred to as (C) (pl. A, fig. N).

III, Ia.—This was first observed in a few of the amphibians. In the femora of these animals the system was merely a minute, more or less irregularly shaped, canal, extending in a direction parallel with the long axis of the bone. In cross-section the canal was round, oval, or irregular in shape and surrounded by a small, clear, more or less circular area of bone substance, across which were seen a few canaliculi on their way from neighboring lacunæ. That is, they were *not* concentrically arranged and appeared to be independent of the canal with the exception of a slight connection by means of the canaliculi. The figure presented merely a suggestion of an Haversian system. This stage of development was found in all classes of animals from amphibians to man. Its characteristic structure may be seen by referring to plate A, figure K.

As one studies the many sections in which this stage is found it is clearly evident that it is associated with the earlier periods of development both phylo- and ontogenetically, since the Haversian canal alone is present, and this occurs in the lamellar areas of the bone. There seems to be no particular relation of the canal to adjacent lacunæ.

III, Ib.—This stage represents a morphological advancement characterized by a more definite relation of neighboring lacunæ to the Haversian canal, and by more extensive communication of the bone cells of the lacunæ with the Haversian circulation. The result is that the Haversian system is fairly well outlined. As this stage is but a step in advance of (Ia) it might be expected to appear in any femur in which (Ia) is present, and to a certain extent this is true. It was observed in all classes of animals excepting amphibians and birds (pl. A, fig. L). It was first seen in some of the reptiles, such as the turtles. In these femora the canal was surrounded by a clear, circular area of bone substance, and the lacunæ were arranged concentrically around the circumference of the area. There was a noticeable increase of the canaliculi passing from the lacunæ to the canal. The whole figure presented a circular form and the Haversian system could be clearly distinguished.

III, Ic.—This stage of Haversian development may possibly occupy a transitional position between the early and late differentiations, although it does not resemble either one very closely. It differs from both in the intricate character of the canaliculi, and in some respects suggests as early a development as that seen in (Ia) or (Ib). The Haversian canal is regular in shape and small in size. The lacunæ have assumed a definite concentric arrangement around the canal, and, with their bushy, branching canaliculi forming a delicate network, occupy the clear area of bone substance referred to under (Ia) and (Ib). The structure has taken on the definite form of an Haversian system and presents a peculiar dull character by which it may be identified anywhere (pl. A, fig. M). This stage was observed in birds only and is easily recognized.

III, C.—This is the completely differentiated Haversian system and belongs to the higher mammals and man. In this stage the dim characters of the incompletely differentiated systems have disappeared. The outlines and structural units of the Haversian systems are clearly distinct. The canaliculi are slightly wavy and parallel (pl. A, fig. N).

Such systems were not found below the mammals nor in the lower mammals, such as the monotremes, marsupials, and some of the edentates and Chiroptera, but were always present in the higher mammals and adult man. Therefore it seems safe to regard this form as the Haversian system of the latest differentiation.

The Haversian system in early or late stages of differentiation, appears also in all classes of animals; but there are wide and often characteristic differences in the variety and extent of such bone. In the amphibians it is merely an outline, but in its extension through the reptiles, birds, and mammals to man, it presents phases of an advancing differentiation. The lower the class the earlier the stage, and the higher the class of animals the more complete the stage of development of the Haversian systems. The development seems to be one of a transformation of the first bone type into a third by some plan of arrangement, since a complete Haversian system is composed of concentric lamellæ enclosing an Haversian canal. The earlier stages are generally found in all classes of animals in which the first type bone is present as a characteristic structure, and the later stages are found more especially in those classes in which the first type is disappearing or has disappeared.[1]

[1] In addition to the ordinary method of Haversian system development one or two other peculiar forms were observed. In a fractured femur of a frog the upper and lower fragments were united by new bone formed around them. The new bone was cancellous or channeled in character and in some of the meshes lamellæ were concentrically deposited until the meshes were filled with the exception of small canals in their centers. The results, at least in appearance, were Haversian systems (pl. A, fig. O; pl. I, figs. 5, C, E, F). Such results were rather unexpected since there was no structure in the original femur which in the least resembled an Haversian system or even cancellous bone.

Another peculiarity was observed in some second type (laminar) femora, as those of the domestic pig and wild boar. In these bones small, circular enlargements of the concentric canals between the

Frequency of Occurrence

The distribution of the three types of bone, their stages of development, and divisions may be seen in the following table:

DISTRIBUTION OF THE THREE BONE TYPES AND THEIR DIFFERENTIATIONS

Type		Amphibians	Reptiles	Birds	Bats	Other mam'ls	Adult man	Fetal man	Total
	Number of femora examined..	39	34	40	55	133	139	7	440
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
I.	Lamellæ, uniform throughout..	26	60	30	73	0	0	0	19
	Lamellæ, twofold division....	51	17	7.5	16	2	0	0	14
	Lamellæ, threefold division....	20	6	5	9	0	0	0	4
	Lamellæ as cancellous bone....	3	17	5	0	46	92	100	46
	Lamellæ as important bone structure..................	100	100	47	100	48	92	100	79
II.	Laminæ, incomplete differentiation.....................	5	9	25	0	10	0	100	18
	Laminæ, complete differentiation.......................	0	0	0	0	40	8	0	1.4
	Laminæ as important bone structures..................	5	9	25	0	50	8	100	21
III.	Haversian system, Ia..........	21	21	5	5	39	32	14	27
	Haversian system, Ib..........	0	23	7	7	28	6	71	15
	Haversian system, Ic..........	0	0	82	0	0	0	0	7
	Haversian system, C...........	0	0	0	0	82	100	0	54
	Haversian system, incomplete differentiation..............	21	52	89	12	67	38	18	46
	Haversian system, complete differentiation..............	0	0	0	0	82	100	0	54

Looking over the above table it will be noticed that lamellæ, in some stage of differentiation, form an important part of the majority of all femora, and, therefore, may be considered as the simplest, oldest, and most universal bone units; that the first type of bone, without concentric divisions, has a wider range than it has *with* concentric divisions, and that cancellous bone—which is first type with a special arrangement of lamellæ—is found in *all* classes of animals; that laminæ—incomplete or complete—are found in the smallest number of femora, and that Haversian systems, in some stages of differentiation, are found in the largest number of femora and to the greatest extent in man. The early differentiations of the Haversian systems are found in 46% and the late in 54% of all femora examined. There are more early differentiations in the lower animals and more late differentiations in man than in the lower animals. Early and late differentiations may occur in the same bone and more especially in mammals and man, as may be seen in such femora as represented in plate 31, figure 399.

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two laminæ occurred at intervals. Around these enlargements two to four concentric lamellæ were arranged, the whole figure presenting the appearance of a small Haversian system (pl. A, fig. P).

These are referred to in the detailed description as aberrant forms of the Haversian system.

Type Combinations [1]

In a large number of femora the three structural types—first, second, and third—are seen represented simultaneously in various proportions and form what may be called type combinations. As a rule, in these combinations, the various types occupy similar positions in all the adult femora that present such combinations. Usually first and second type constituents surround the femur peripherally and encircle also the medullary canal, while the third type bone forms the central portion of the sections. The bone units in these cases show varying stages of development.

While the single types occur as the sole structures in the femora of some amphibians, reptiles, birds, mammals, and man, a large number, perhaps the majority, are composed of various combinations of these types. There may be a marked difference in the degrees of differentiation present in the several structural units in the same bone.

About 60% of the whole number of femora examined presented combinations of bone types. The first and third were found in association in the largest number.

Type of Bone Structure According to Classes of Animals

AMPHIBIANS

In these animals the type of bone present in the various species showed generally evidences of a progressive character in the structural units. There was observed a change in the shape of the lacunæ from round to long and narrow, in the canaliculi from short and bushy to long and straight, and in the arrangement of the lacunæ from diffuse to concentric. There was also noticed

[1] The most common type combinations are as follows:

I-II. This combination is composed of lamellæ and laminæ. It is seen more especially in fetal femora. In young bones the lamellæ generally occupy the peripheral portion of the bone, and become separated into laminæ nearer the medullary canal. As differentiation advances, much of the first type (lamellar) structure changes gradually into that of the second type (laminar) (pl. C, fig. 1).

I-III. This is a combination of lamellæ and Haversian systems. The lamellæ form a sheath of varying thickness around the bone and enclose either wholly or partly a ring of Haversian systems, also of varying thickness. The Haversian systems may be of any grade of differentiation (pl. B, fig. 7; pl. C, fig. 2).

II-III. This is a combination of laminæ and Haversian systems. The laminæ, generally, form thin, concentric sheaths around a stout ring of Haversian systems (pl. B, fig. 8; pl. C, fig. 3). Here again the Haversian system may be of various grades of differentiation. If the laminar structure is of advanced type, the Haversian system is also; but if it is not, the Haversian system appears in some of its earlier forms.

I-II-III. This is a combination of lamellæ, laminæ, and Haversian systems. The simple lamellæ are generally located externally, the laminæ more internally, and the Haversian systems form the central portions of the bone. The Haversian systems may be of any grade of development. As a rule, the lamellæ and laminæ are well developed or fairly well developed in these forms of bone, while the Haversian systems vary considerably in their degree of differentiation (pl. B, fig. 9; pl. C, fig. 4).

the separation of the uniformly lamellar wall into two and three concentric divisions, the presence of laminæ in *Bufo americana* and *Hyla gratiosa,* and the appearance of Haversian canals of the (Ia) differentiation in the Surinam and other toads (pls. 2-3, figs. 6-39).

REPTILES

The reptiles seem to be divided in the matter of bone differentiation into two groups—the division occurring between the lizards and the turtles. The first group, which includes the lizards, is characterized by the first type bone structure and the second, including the turtles, by the first and third. Belonging to the lizard group in their type of bone were the femora of the *Python regius,* which were composed of crude first type structure with a twofold division. The femur of the alligator represents a later differentiation than that of the lizards and snakes, inasmuch as the second and third types have appeared. Both of these units have reached a later degree of development than they have in any femur preceding them in the zoological scale, while they are not as far advanced as they are in the turtles which follow them. Comparing the class of reptiles with that of amphibians the chief evidences of type advancement are seen in the more complete differentiations of the third type units (pls. 3, 4, figs. 40-73).

BIRDS

The study of the femora of birds is, to some extent, unsatisfactory. While the three types of bone structure are present, either alone or in combination, they generally bear more or less of a transitional character. The several units —lamellæ, laminæ, and Haversian systems—show, usually, incompleteness of development. In some instances, it is difficult to recognize any distinct type. On the whole, however, evidences of advancing differentiation are prominent in birds, since all three units have appeared and generally in a more complete form than in the femora of reptiles or amphibians.

The first type of bone (lamellar) is present in some species, as in the robin, and is of a very simple form. The second (laminar) appears in a larger number of species, as in the turkey, grouse, and ostrich, and is, perhaps, the most representative type among birds. The laminæ, generally, show an incomplete differentiation. The third type (Haversian systems) is found in several species, and presents distinct characters by which they can be distinguished from the Haversian systems of other animals.

In some cases Haversian systems are present in the posterior ridges, in others, of larger size, in the posterior ridges and anterior walls, and in still others they form the entire central ring (pls. 5, 6, 7, figs. 74-112).

MAMMALS

The femora of mammals, not including man, present the first, second, and third type units and most of their combinations. As far as can be determined microscopically, these units are the same as were present in the amphibians, reptiles, and birds; but on the whole, they show a more advanced differentiation.

Since the complete Haversian system does not appear in amphibians nor in reptiles nor clearly in birds, and does appear in mammals as a predominating structure and often in a high degree of differentiation, its general presence to such an extent and to such a degree of advancement points to the age of mammals as the most important period in the history of bone development.

For convenience in description the bats are treated separately since they do not resemble other mammals as closely as they do some of the lizards.

Bats.—Practically the whole order has been covered, and from the drawings, descriptions, and tables it will be seen that the bat femora are generally true to the first type bone. The sections are composed of lamellæ with round, oval, or long and narrow lacunæ, arranged concentrically around the medullary canal.

The sections are uniform in structure with the exception of a small number in which we find the twofold or threefold lamellar division. Very few structural variations have occurred in the whole order. In the genus Pteropus, which included the largest bats, Haversian canals of the early differentiation are present, and, generally speaking, the femora of the larger species have more of these canals than those of the smaller (pl. 8, figs. 113-166).

Other mammals.—The femora of the fetal sheep, calf, and pig of half-time development and also those of many adult mammals were examined.

In the fetal sheep the type of bone was an incomplete second with short, wide, irregular communicating canals. In the femur of the adult sheep the type was also second; but the laminæ had become regular and concentric and the canals between them much narrower and more regular. In the fetal calf the type of bone was very indistinctly second, with numerous bizarre-shaped canals. In the adult ox the type had become a well developed second and third.

In the fetal pig the type was second and, with the addition of a few Haversian systems in the posterior wall, remained second in the adult (pl. 11, figs. 199, 200, 201).

The most pronounced developmental change was observed in the femur of the calf.

The whole range of differentiation in minute bone structure reaches, generally speaking, the greatest advance in the mammals exclusive of bats.

The often more or less vague character of the structure in lower animals clears up to a marked degree, and the bone units stand out as finished products. Types and type combinations are now distinct. Pure types are found in many instances, though combinations of types are the most numerous and characteristic of mammalian bone. The Haversian systems have differentiated into their later stages, to reach their highest degree of perfection and prominence in man (pls. 9-20, figs. 168-298).

Man.—In human femora the bone structure, as already mentioned in part, reaches, in many respects, the climax of its differentiation. The human femora examined were the fetal and adult. The fetal bones belonged to the black and white races, the adult to the black, yellow-brown, and white including the ancient Egyptian. The number of fetal femora examined is small, but the results indicate that the study of the comparative histology of a larger number of fetal bones, not only of man but also of other animals, would clear up many interesting points in the differentiations which are found in the adult (pls. 21-35, figs. 306-453).

Fetal human femora.—These femora, representing the whole period of intra-uterine life, showed basic bone substance in the early, and differentiated lamellæ and laminæ in the later months; also there was observed the horseshoe-shaped band forming the anterior and lateral wall and the separate formation of the posterior ridge (pl. 21, figs. 299-305). (For details see section III.)

Adult femora.—Generally speaking, the adult human femur is characterized by the predominance of completely differentiated third type units. An exclusive first type was not found in the adult bone. The most primitive form was a first and third combination. The proportions of the structural units (lamellæ, laminæ, and Haversian systems) vary greatly. In some femora first type bone amounted to more than half of the sections; in others it was reduced to a small fraction; in still others there was a second and third instead of a first and third; and, finally, some femora showed the first, second, and third type bone in various combinations.

When first type bone is present in the human femur it is found in the form of a horseshoe-shaped band situated underneath the periosteum. The inter-Haversian lamellæ, frequently present in sections of human femora, are apparently the remains of the disappearing horseshoe band just described. In a fully differentiated human bone, Haversian systems form the whole structure.

The three races, black, yellow-brown, Egyptian, and white, exhibit similar types and combinations of types of bone structure. In each there is a first and third, second and third, and complete third type, with or without senile changes. As a race the white presents more third type femora than the black or yellow-brown race. Early (primitive) and late (advanced) differentiations have been found in the different femora of the negro, Pueblo, and Peruvian Indians, the ancient Egyptian, and modern white. The linea aspera in the adult human femur is always composed of Haversian systems. Senile changes, absent or rare in other animals, are unexpectedly frequent in human femora.

The best type of human femur is composed wholly of Haversian systems of the complete differentiation. The systems have long, narrow lacunæ, with long, straight canaliculi situated between or within concentric lamellæ which enclose the Haversian canal. External and internal circumferential lamellæ form in some instances very narrow rings around the bone and medullary canal, or they may be fragmentary. Such femora are not very common.

Black race.—The femora of the black race exhibit types and combinations of types ranging from a first and third to a complete third. The majority of bones examined are type combinations. In some femora a wide horseshoe-shaped band of lamellæ, enclosing Haversian canals of the early incomplete differentiation and a few, scattered, small Haversian systems, is found partly surrounding a narrow, central ring of completely developed Haversian systems. In others the horseshoe is narrower, and the central ring of Haversian systems is wider; that is, the proportion of the horseshoe band to the Haversian ring is a variable quantity. In still other femora the horseshoe forms a fragmentary background which can be distinguished, but which has been mostly displaced by fully developed Haversian systems (pls. 21-23, figs. 306-324; pl. 25, figs. 335-340).

The negro femur has a higher medullary index than the white or Egyptian race.

During the examination of the right femur of negro No. 248674, U. S. Nat. Mus., it was observed that considerably more than half of the section was first type bone, in which were many Haversian canals of the primitive and incomplete differentiation. It was then decided to examine all of the long bones of that negro in order to ascertain, if possible, whether or not the structure was basic in character. Accordingly, the left femur, tibia, fibula, radius, ulna, humerus, clavicle, and metatarsal bone of the great toe were examined. The result was they were all found to conform closely to what was found in the right femur. It was therefore concluded that the type combination found in the femur was a representative type of the whole long bone formation of that particular negro, and that one type or type combination would probably not be found in one bone of an individual and a different one in another (pl. 24, figs. 325-333).

The yellow-brown race.—With one exception these femora were pre-Columbian. They were a little smaller than those of the blacks. The majority were composed of second and third, and first, second, and third type combinations. Only three or four were pure third type. In the femora, composed of type combinations, there was a greater average proportion of first type bone than was present in the other races examined.

The medullary canals were relatively larger than in the other races, as may be seen from their medullary indices—yellow-brown 43.8%, blacks 41.9%, Egyptians 39.5%, and whites 38.5%. Therefore the yellow-brown femur has proportionately a smaller percentage of bone substance than the femora of other races (pls. 25-27, figs. 341-361).

Egyptian femora of the twelfth dynasty.—This series includes the femora of children, youth, and adults. The bones are interesting on account of their antiquity. They show the structure of the femur of four thousand years ago. By comparing them with modern femora it will be seen that the bone types which were prominent then are still prominent now.

One of the most interesting femora examined was that of a young child, figures 363 and 363-a. It showed the formation of an Haversian system from the circulation, an account of which will be found elsewhere (p. 177). Two or three femora from adolescents showed gradually diminishing first and second and increasing third type units. The adult bones showed two main types of differentiation. One was composed of lamellæ enclosing Haversian systems, and the other of Haversian systems alone, figures 369 and 370. Femur 369 bears the stamp of a much lower degree of development than femur 370. Femur 369 was much more than half lamellæ, while 370 was composed entirely of Haversian systems (pls. 27-28, figs. 363-371).

The white race.—The femora of the modern white race showed a variety of type combinations as well as single types. On the whole, the complete Haversian system type predominated. A larger percentage of the bones examined than in any other race showed the third type structure and senile changes. Individual differences in structure were quite extensive.

The average medullary index, as already seen, was 35.8%. That is, the femur of the white race had a smaller medullary canal and thicker wall of bone than the femur of the other races. In the III, C type of femora the Haversian systems varied considerably in size. Some were small with a few, while others were large with many, concentric lamellæ. The communicating canals between the systems also varied greatly. In some femora they were very numerous and provided a rich blood supply for the whole bone; in other femora they were few in number, comparatively, and the Haversian circulation was very much diminished. Differences in the extent of the circulation in different parts of the bone were observed. The inner wall generally had more inter-Haversian canals than the outer, while the posterior ridge (linea aspera) had a much richer blood supply than the anterior wall (pls. 28-35, figs. 372-453).

In those femora which showed combinations of types, the proportions of the units were found to vary greatly. In some the proportion of lamellæ was considerably over 50% of the whole bone, and in others varying percentages of lamellæ and laminæ from 50% to 0% were observed. In only a few cases the femora composed of Haversian systems alone were without senile evidences. From an examination of two entire human femora of the white race at intervals of 2.5 cm., it was further determined that sections through the middle of the shaft represented the entire structure of the bone with the exception of the extremities.

Factors Influencing Types of Bone Structure

1. Grade of the animal in biological classification.
2. Geographical location.
3. Sex.
4. Age.
5. Function.
6. Individuality.
7. Health and disease.
8. Heredity.

The results of the investigations in these directions are here briefly summarized.

1. THE GRADE OF THE ANIMAL IN BIOLOGICAL CLASSIFICATION

It is, perhaps, impossible to decide just how much *is* evidence in regard to the relation of grade to structure. In the specimens of the different femora examined there were found many variations which, doubtless, have some significance. On the one hand, there are evidences which tend to show that the grade of an animal has an influence in limiting the structural bone type present; but on the other, there are counter evidences which indicate that the whole matter is not so simple. In support of the first view is the fact that the position which the animal occupies in the scale of life is generally in harmony with the type of bone present in its femur. That is, the lowest class of femoral vertebrates, the lowest order of any class, the lowest genus of any order, and the lowest species of any genus, all show the simplest and most primitive types of bone structure. The converse is also equally true—that the highest class, order, genus, and species shows the most advanced or highly developed type of bone. This may be seen from the specimens, tables, and drawings. While each class, order, genus, and species seems to have a bone cycle of its own, the various cycles are bound together by some factor of an advancing differentiation and the high [1] bone units in one class, order, genus, or species become higher in the next in succession.

But there are exceptional features which remain to be explained. Each class of animal—amphibian, reptile, bird, mammal—has some first type bone species. Each class, order, genus, and species shows an early and late differentiation of bone units. While each class of animal seems to be complete in itself,

[1] The terms high and low do not refer to exact states, but to relative distinctions in differentiation.

there is apparently some underlying determinant which gives to the higher group a more complete differentiation than is found in a preceding or lower class. That is, the late differentiation in mammals is more complete than it is in birds, in birds than it is in reptiles, and in reptiles than in amphibians; while the early differentiation in each class seems to remain practically the same. As the animal rises in the scale of differentiation, the grade of the adult bone type also rises. As far as the microscopic appearances are concerned it is difficult, if not impossible, to tell when bone units of structure have become complete, but it is not difficult to observe that they have advanced as we go from one class to another.

2. GEOGRAPHICAL POSITION

The effect of geographical position upon bone variation is not yet reducible to exact deductions. The majority of the femora of amphibians have the first type of bone structure and this, too, regardless of their geographical location. The same is true of the lizards and bats. Perhaps the bats furnish the most important example. As said already, practically the whole order was examined. The individuals came from all parts of the world where bats abound, and they all showed the same type of structure with very little variation. Some mammals of different locations are alike in structure and some are unlike.

In respect to man, the femora of the ancient Egyptians differed from one another greatly, although they were taken from the same cemetery. The same is true of the pre-Columbian Chicama and Pachacamac Indians. In the modern races variations in type are very common and they cannot, in the writer's experience, in any way be associated with geographical position.

As far as the present observations are concerned, therefore, there is no reason to suppose that geography has had any marked influence upon bone type.

3. SEX

In reference to sex, it may be briefly stated that the femora examined showed no conclusive evidence that sex was an important factor in the minute structural variation of bone.

4. AGE

Unlike the previous factors, age influences the type of bone very considerably. In the higher mammals and man the femora invariably change in structure with the advancing age of each individual. Some femora arrive at completion earlier than others. In the formation of the human bone from early fetal types there were to be seen distinct evidences of progressive changes from the first through the second to the third type. In some cases this course of development was completed much earlier than it was in others, and senility appeared to a greater or less degree in the Haversian systems of such femora; in one instance senile changes were manifest although the individual was not over 35 years of age.

5. FUNCTION

The effect of function upon variation in bone structure can scarcely be doubted in some instances, while in others there seems to be little or no evidence of it. In amphibians the largest bones have the most Haversian canals. This, however, is only true as a general rule. For example, the frog has no Haversian canals or laminæ, while the toad, which may be smaller than the frog, shows both laminæ and Haversian canals. In reptiles, the small lizards do not have the Haversian canals, while the larger ones have many. On the other hand, a large alligator has very incomplete Haversian systems, while a small turtle has more advanced third type units. Again, small turtles have few, while the large ones have many, Haversian systems. In birds, some of the larger varieties, as the ostrich, have predominating second types and not the third, while many small birds have predominating third type units.

A turkey of 16 pounds weight has the second type of structure with a few Haversian systems, while a turkey of 32 pounds has the same type with a noticeable increase in the number of Haversian systems. That is, size or weight seems to have a decided influence upon third type bone development in some cases, and little, if any, in others.

In mammals of the same species, provided the species has Haversian systems, there will be more of these systems in the larger than in the smaller varieties. But in animals of different classes the larger species may have, on the average, no more Haversian systems than those of the smaller species. For example, a domestic pig, weighing 500 pounds, has a second type bone with some Haversian systems, while a domestic turkey, weighing 32 pounds, has also a second type bone and nearly as many Haversian systems. The two bones of different classes differ from one another very materially in differentiation of both types, but not in the types themselves. In bipedal mammals of considerable weight like man, in which the weight of the animal is borne by two legs instead of four, there is a greater tendency towards the third type bone, and yet there are many exceptions. Furthermore, the os penis of the raccoon is an Haversian system bone, and conforms, generally, to the femoral type of that animal. In this case it is evident that function has had no effect on bone structure (pl. 20, fig. 288).

A cessation of function in an adult bone favors the appearance of marks of senility. There is a difference between a rudimentary femur without function and a normal bone which has lost its function by accident. The rudimentary femora of the python are first type bones like those of the lizards, and although the femora are useless, their bone units are apparently sound; while in human femora amputated several years before examination the structure is well differentiated, but shows premature senile changes.

6. INDIVIDUAL VARIATIONS

Individual variations are by no means as common in the lower femoral vertebrates as they are in the higher forms. They are found to increase in the frequency of occurrence from birds to man. As far as the higher vertebrates are concerned, hardly any two individuals are exactly alike. They conform to a general type of structure which is fundamental, and exhibit special variations which are peculiar to the individual. This was found to be the case even with cats of the same litter. The individuals varied in structure.

7. HEALTH AND DISEASE

Variations due to health and disease remain very largely for studies in the future. However, the right femur of an adult white male who had congenital epilepsy shows an extremely thin wall (1 mm. to 2 mm. in thickness), and an index of 277%. See plate 35, figure 453, for drawing and text for description.

8. HEREDITY

The influence of heredity on bone variation requires a greater amount of selected material of known genetic relationship than the writer has been able to gather. Most of the femora utilized are those of individuals with no obtainable family history. However, the femur of the mule resembles structurally the jackass more than the horse, and the femora of a litter of kittens showed quite marked differences. Excluding other causative factors which do not sufficiently account for the variations observed, heredity offers a most attractive field. The further study of bones of the descendants of known ancestors, and of selected crossings, is especially desirable.

Conclusions

If we survey the whole field of bone histology, as it was observed during the present investigation, the following salient points stand out with sufficient clearness:

1. The predominant shape of cross-sections of the femora of the animals below man is elliptical.

2. Generally speaking, first and second type femora are circular or elliptical and third types are triangular or related shapes.

3. Medullary canals are situated centrally, eccentrically, or obliquely, and may be circular, elliptical, or irregular in shape.

4. The medullary surfaces may be smooth, roughened by depressions, or corrugated.

5. Medullary contents are composed of marrow and its blood vessels, of marrow and cancellous bone, of trabeculæ alone, or the contents may be entirely absent. About half of the bird femora have full medullary canals, while the remaining half have no contents.

6. The medullary index (relative thickness of bone compared with the medullary canal) is lowest in reptiles and highest in birds. It falls from amphibian to reptile, rises from reptile to bird, falls rapidly from bird to mammal, and is about the same in man as in the lower mammals. The reptiles have the highest percentage of bone, the amphibians next, the mammals next, the modern white race of man next, and the bird the lowest percentage. Of the human race the modern white has the most bone, the Egyptian next, the negro next, and the American Indian the least.

7. The femora of the different animals and in man, even those of different individuals, vary in density, and the single femur varies in the density of the different parts of its wall.

8. Lacunæ and canaliculi present various stages of differentiation, the character of the differentiation being harmonious with, and indicative of, the degree of bone development.

9. Lamellæ, laminæ, and Haversian systems appear in bone in the order given, and become the basis of the types and type combinations of bone structure which enter into the formation of the different femora.

10. Basic bone substance is differentiated into lamellæ when the diffuse arrangement of lacunæ becomes concentric.

11. Cancellous bone is present in all classes of animals, and is more frequently observed in large than in small bones.

12. Three types of structure form the basis of all femora. They may occur singly or in combination. The first and second predominate in amphibians, reptiles, and birds, the third in mammals and man.

13. The first type, composed of lamellæ, appears as a uniform structure, or in a twofold or threefold division, and characterizes the amphibians, lizards, and bats.

14. The second type (lamina) appears first in the amphibian, and in an early or late form of differentiation in birds and lower mammals.

15. The third type (Haversian system) is first outlined in the amphibians. It is the result, primarily, of a series of differentiations beginning with the amphibians and ending in man.

16. Combinations of types are of frequent occurrence.

17. In fetal and young femora the differentiation of first into second and second into third types of bone structure was observable.

18. The presence of the early differentiations of type in some black, yellow-brown, white, and Egyptian femora, and of the late or complete differentiations in other femora of the same races was observed.

The following evidences of type advancement appear in the different classes of animals:

Amphibians.—A change of round to oval and long lacunæ, and from their diffuse to their concentric arrangements, a transformation of basic to lamellated bone, the separation of the uniformly lamellated bone structure into a twofold or threefold division, and the formation of distinct laminæ and Haversian canals in the walls of the femora, were all observed in the amphibians.

Reptiles.—The extension of lamellæ and the further development of laminæ and Haversian systems were seen in the femora of reptiles.

Birds.—The extension of lamellæ, prominent development of laminæ, and advancement of Haversian systems were observed in these animals.

Mammals.—Extension of lamellæ, completion of laminæ, and a much better development of Haversian systems were observed in mammals.

Man.—Extension of lamellæ, laminæ, and the completion of the Haversian systems were seen in human femora.

III. FETAL HUMAN FEMORA AND THEIR FURTHER DEVELOPMENT

Type differentiations, changes in the medullary index, and position of the medullary canal, development of the linea aspera, and changes in the shape of the shaft of the femur, are shown very interestingly in these bones, as may be seen from the following descriptive observations.

The fetal bones examined, mostly of the white race, varied in age from two and one-half to nine months. The young bones of two and a half months were composed of a crude, undifferentiated bone substance, with round lacunæ and short, bushy canaliculi, enclosing large irregularly shaped meshes. The medullary canal was very small and irregular in shape, and together with the meshes was filled with marrow. It was situated in the center of the section, and immediately surrounded by a narrow ring of lamellæ, thus showing the twofold division observed in some of the lower animals. The diameters of the bone were, the antero-posterior 1.8 mm., the lateral 1.5 mm., and of the canal 0.5 mm. × 0.4 mm. (pl. 21, fig. 299). The antero-posterior diameter at this stage of life was longer than the lateral. A little later (three to three and one-half months) the same diameters were respectively 2.5 mm. × 2 mm., while those of the medullary canal were 0.5 mm. × 0.5 mm. The canal was situated eccentrically in the anterior half of the section, was only a trifle larger than the canal of the younger bone, and was surrounded by a narrow ring of lamellæ, also showing the twofold division (pl. 21, fig. 300). Comparing this section with the preceding it was noticed that a structural variation had already appeared in the latter bone. The irregular meshes seen in the former were considerably elongated. They had assumed canal shapes and were arranged concentrically. Basic bone substance, with round lacunæ and bushy canaliculi, formed the reticulum between the elongated meshes or canals. Furthermore, a difference in structure was noticed between the posterior and remaining wall. In the posterior wall the concentric arrangement of the canals, described above, was absent, and a general direction of the canals from the medullary canal toward the external surface of the posterior wall was assumed. Here and there in the bone substance between the canals an Haversian canal of the (Ia) differentiation appeared. This whole posterior structure was the beginning of the linea aspera, and seemed to be a distinct bone formation.

In still later femora (four or five months) the diameters of the shaft were 3.5 mm. × 2.5 mm., and those of the medullary canal were 0.6 mm. × 0.5 mm. The medullary canal was situated eccentrically. The section was composed of basic bone substance, enclosing wide, branching, concentric canals, giving the appearance of a very primitive second type formation. The posterior wall was more prominent, and composed of bone substance with round and oval lacunæ, enclosing long, wide, branching canals, directed toward the external surface and at right angles to the structures of the lateral wall. The distinction between the posterior and lateral walls was more pronounced than in the specimens of earlier femora (pl. 21, fig. 301).

In still older femora (five to seven months) a distinct difference between the posterior wall, which now appears as a ridge, and the remaining walls was observed. The diameters of the bone were 3.5 mm. × 3 mm., and those of the medullary canal 0.5 mm. × 0.5 mm. The canal was situated eccentrically. The bone was composed of concentric laminæ arranged in the shape of a horseshoe, enclosing, in part, the medullary canal. The toe of the shoe formed the anterior wall and the heel embraced the posterior ridge. The posterior ridge was composed of elongated Haversian systems, as they appeared in cross-section, with large, wide Haversian canals extending outward toward the external posterior surface and at right angles to the laminæ of the remaining wall. In cross-section the posterior ridge was wedge-shaped and clearly distinct. The laminæ of the remaining wall were incompletely differentiated. They were wide, and composed of bone substance with round and oval lacunæ and bushy canaliculi (pl. 21, fig. 302).

In the femora of the final stages of fetal development (eight to nine months) the diameters of the bone were 4.5 mm. × 5 mm., of the canal 1 mm. × 1 mm. In these bones the lateral diameter was longest. The medullary canal was irregular in shape, larger, and situated eccentrically. The bone was composed of elongated, concentric Haversian systems (in cross-section) arranged in horseshoe shape around the medullary canal. The systems were composed of bone substance with oval and long lacunæ and with bushy and straight canaliculi. They gave one the impression of Haversian systems very much flattened by pressure. The posterior ridge or linea aspera, clearly distinct and wider than in the foregoing sections, was composed of elongated Haversian systems, and was divided into two lateral halves by a narrow radiating space, which is the last part of the linea aspera to become bone (pl. 21, fig. 303).

In a series of five Pueblo Indian femora of different ages, from one year to adult age, various further developmental stages were shown (pl. 9, figs. 341-344). The child's femur was composed of incompletely developed laminæ and Haversian systems, the systems ranging from the (Ia) to the (C) differentiation. The posterior ridge, only partly formed in the femur of one year, was much further advanced in the femur of six years. In the femur of early youth the laminæ were, to a considerable degree, displaced by incompletely developed Haversian systems, and the posterior ridge could not be distinguished from the lateral wall. In the femur of later youth the Haversian systems have increased in proportion and advanced markedly in development, and in the adult bone the lamellæ and laminæ were almost entirely displaced by fully developed Haversian systems. While these femora were from different individuals and probably from individuals of unlike types; yet they showed, in a general way, the differentiating changes in bone development. The Chicama and Pachacamac Indians showed similar changes.

Reviewing the above differentiations chronologically, evidences of advancement were strikingly apparent with increase in age. The femur of the human fetus begins its osseous history as a bone of crude first type, and then gradually advances through the second to the pure third type, or to some combination of the first and third, second and third, or first, second, and third types. Haversian systems begin with the most primitive, incomplete, and advance to the fully developed stage, gradually increasing at the same time in number. An early twofold division of the femoral wall increases to a threefold division.

It may also be seen that the linea aspera of the human femur is the product of a distinct bone formation which occurs in the posterior wall. It was noticed at the early age of three and one-half months, and was observed in the different femora until birth. Therefore, in the formation of the shaft of the human femur, two distinct bone forming processes seem to be evident, one the formation of the horseshoe-shaped band of the anterior and lateral walls, and the other of the posterior ridge or linea aspera. They appear to go on independently of each other for a while, and fuse together some time after birth.

The development of the linea aspera—the last part of the shaft to be completed—is especially interesting from the viewpoint of its function and the growth of bone.

IV. HISTOLOGICAL EXAMINATION OF TWO ENTIRE HUMAN FEMORA—GENERAL DESCRIPTION

As all of the sections were made through the middle of the shaft, and the descriptions given applied only to the structure of one location, it was desirable to examine sections of entire femora of different types in order to determine to what extent the structure of the middle of the shaft represented the whole femur. With this object in view, two entire femora have been examined. In each bone the first section was made transversely through the middle of the head, and the remaining sections at intervals of 2.5 cm. The two femora represented two types of differentiation—one, I-III, C, senile, and the other, III, C, senile.

The first femur (length 41 cm., No. 300, Cr. Med. Coll.).—This was composed of a predominating proportion of lamellæ interrupted by Haversian systems of the (Ia) and (C) differentiation, enclosing a narrow ring of Haversian systems of the (C) differentiation, many of which were senile. This femur, therefore, represented a human bone with incomplete development.

The structural type remained the same throughout the entire femur, but the different sections showed variations in medullary indices, proportions of lamellæ, cancellous bone, and senile changes. The medullary indices diminished from the extremities of the medullary canal toward the middle of the shaft, and were lowest 15 to 20 cm. below the section of the head.

The proportion of the lamellæ to the enclosed Haversian systems increased gradually from the head to the lower extremity. The cancellous bone diminished from the extremities toward the middle of the shaft. The senile changes were most numerous in the middle of the shaft and in the anterior wall.

On the whole, the bone was composed of an external, thick sheath of lamellæ enclosing a thin, shorter sheath of Haversian systems, and a section through the middle of the shaft gave a fair representation of the whole bone structure, excepting that of the two extremities.

It was noticed during the grinding of the middle sections that the lamellar and Haversian system rings were easily separated from one another, and that they were readily fractured in the anterior wall in which senility was most marked.

Second femur (length 38 cm., No. 301, Cr. Med. Coll.).—The upper portion of this femur was composed almost entirely of well developed Haversian systems and the lower portion of lamellæ and Haversian systems. The lamellæ formed a wide external band situated in the anterior wall, and were frequently interrupted by Haversian systems, some of which were senile.

The bone represented a human femur of a much later differentiation than No. 300, although it was not entirely a pure third type bone. The principal variation from the third type was limited to the lower portion.

The medullary indices diminished from the extremities toward the middle of the shaft, and were lowest 15 to 17 cm. below the section of the head. The band of lamellæ began 20 to 22 cm. below the head, and was most pronounced in the anterior wall. It extended downward toward the lower extremity, and, gradually diminishing in thickness, finally merged into the thin envelope of lamellæ surrounding the condyles. Cancellous bone diminished from the extremities toward the middle of the shaft, and was entirely absent from the middle third of the bone. Senile changes, not very marked, were most frequent in the middle portion and the anterior wall.

A section through the middle of this femur, compared with the remaining sections, did not give as fair a representation of the whole bone structure as the corresponding section of femur No. 300 gave to that bone. However, it did show plainly the type of bone to which this femur belonged. Notwithstanding, the lamellar band in the anterior wall of the lower portion, the characteristic unit of the whole bone was the Haversian system.

The heads and condyles of both femora were composed almost entirely of lamellæ.

V. SENILITY

After reaching its highest degree of development, as indicated by the character of its lacunæ and canaliculi, the Haversian system may remain in this condition for a time, but sooner or later the dissociation of the organic and inorganic constituents begins to appear, and the system gradually becomes granular, opaque, and black. The sum total of the processes by which these results are obtained is age or senility.

An examination of the various sections shows that this condition is more common than would be expected, and that, too, regardless of age in years. A human femur may be more or less senile at 35 or any subsequent age.

Adult human femora in general show a much larger percentage of senility than the femora of the lower animals. From a review of the various sections it may be seen that senility does not seem to appear at all in the amphibians, reptiles, birds, or bats, and was seen in only five or six of all the remaining mammalian femora; while it is found in the majority of femora of the white human race. Just when the amphibian, reptile, bird, or mammal becomes adult, just how long this period of life lasts, or when old age sets in, are not known.

The fact that senile changes are so prominent in the lamellæ of Haversian systems and so infrequent in the lamellæ of other situations suggests a difference either in the variations of the blood supply or in the chemical stability of the bone substance, or in both. The circulation is more complicated in a third type bone than it is in a first or second, and therefore more subject to structural deviations.

In a senile Haversian system, at the beginning of the process, the lamella around the Haversian canal becomes dark from a deposit of inorganic granules. This deposit intensifies the clearness of the serrated edges and cement. The granules increase as the process goes on, involving lamella after lamella, until the whole system is opaque and black. After the lamellæ have reached this stage they are gradually broken down into amorphous particles which drop into the Haversian canal and are removed by the blood vessels. The lamellæ of adjoining systems pass through similar processes. The inter-Haversian lamellæ follow and a cavity is formed, which in the section appears as a space. This process continues with a greater or lesser rapidity until the bone, reduced in dimensions and weight, remains as a mere shell of its normal condition (pl. 34, figs. 423-426).

In plate 29, figure 381, these changes may be observed. Haversian systems in different stages of senility are most numerous in the anterior and outer walls and in the middle portion of the shaft of the bone. The systems may be in pretty good condition elsewhere or, in extreme cases, granular deposits of different degrees of intensity may be present in most of them. The internal circumferential lamellæ remain in a fragmentary form. The essential change, therefore, is primarily in the Haversian system.

The changes which occur in senility may be summarized, as follows:

1. Dissociation of the organic and inorganic constituents of the lamellæ around the Haversian canals.

2. Deposit of inorganic granules in the lamellæ around the Haversian canals.

3. Gradual extension of the inorganic deposit toward the periphery of the Haversian systems and opacity of the lamellæ.

4. Absorption and disappearance of the granular lamellæ from the Haversian canal outward.

5. Widening of the Haversian canals and thinning of the walls of the Haversian system.

6. Disappearance of the Haversian systems and formation of irregular spaces. (Deposit of salts in the walls of degenerating vessels.)

7. Decrease in the weight of the bone.

VI. AMPHIBIANS

The study begins with the amphibians. Thirty-nine femora were examined.

General Character of the Femur

The femora of these animals are generally small. They vary to a considerable degree in shape. Some sections are triangular, some elliptical, some round, and a few are indeterminate. In the elliptical sections the lateral diameters are longest. The medullary canals are full of marrow, and in one femur, *Amblystoma tigrinum,* the canal is occupied by cancellous bone. The medullary index varies from zero to 129%, with an average of 36.6%. The type of structure is principally first; the basic or undifferentiated bone substance is found in *Amblystoma tigrinum,* the most primitive of amphibians, the lamellated or differentiated bone in the majority of the remaining species; while the II and III, Ia differentiations occur in the toads. The lacunæ are round, oval, or long, and the canaliculi are short and bushy or long and straight. The structure may be uniform throughout the whole section, or it may present a twofold division, as seen in *Hyla arenicolor;* or a threefold division, as seen in Necturus.

On the whole, then, the amphibian femora show the first type bone, and also mark the beginning of the second and third types.

Detailed Examination

FEMORA OF RANA CATESBIANA. BULL FROG

The femora of four bull frogs were examined, the first unusually large, the second of medium size, the third and fourth small.

They showed different developments of the same type of bone (pl. 1, figs. 1-4).

RIGHT FEMUR OF RANA CATESBIANA (LARGE). FIRST BULL FROG. CREIGHTON MEDICAL COLLEGE

Pl. 1, Fig. 1. Synoptic Table I

Antero-posterior diameter of bone, 3.5 mm.; lateral, 4.5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 16%.

The section is surrounded by a narrow ring of external circumferential lamellæ. Their lacunæ are round and oval, their canaliculi are short and bushy, and all are poorly developed. The central ring, situated between the external and internal lamellæ, is interrupted by many large, bush-like, radiating canals. The lamellæ are indistinct, their lacunæ are round and oval, and the canaliculi communicate with the radiating canals.

The canals are just visible to the naked eye. Some of them extend from the internal to the external circumferential lamellæ, some about two-thirds of that distance, and some are interrupted at various points along the way. The central ring forms about four-fifths of the thickness of the bone, is thicker in the posterior half than in the anterior, and presents a low development.

The internal circumferential lamellæ surround the medullary canal. They are clearer than those of the external lamellæ, their lacunæ are oval, their canaliculi are short and partly in the central ring, and there is a large vascular canal on its way to the medullary canal. The internal lamellæ are poorly developed. The section shows a threefold division.

Type I.

RIGHT FEMUR OF RANA CATESBIANA (MEDIUM SIZED). SECOND BULL FROG. CR. MED. COLL.

PL. 1, FIG. 2. SYN. TAB. I

Antero-posterior diameter of bone, 2.5 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 1.4 mm.; lateral, 1.6 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—Around the bone is a very narrow ring of dense lamellæ containing a few, long, narrow lacunæ and long canaliculi.

In the center of the anterior wall is a notch, which is part of the nutrient canal. Beginning a little to the outer side of the posterior mid-line and extending around the outer wall, anterior, and about one-fourth of the inner wall, the entire thickness of the bone is composed of concentric lamellæ with oval lacunæ and bushy canaliculi. The remaining portion of the bone is composed of concentric lamellæ, which are crossed by short canals, arranged radially in twos and threes. The canals are surrounded by clear areas of bone substance, and extending from them in all directions are very fine canaliculi. The internal circumferential lamellæ are not distinct from the remaining structure. Its peculiar feature is the gradual disappearance of the radiating canals.

Type I.

RIGHT FEMUR OF RANA CATESBIANA (SMALL). THIRD BULL FROG. CR. MED. COLL.

PL. 1, FIG. 3. SYN. TAB. I

Antero-posterior diameter of the bone, 1 mm.; lateral, 1.3 mm.

Antero-posterior diameter of the medullary canal, 0.5 mm.; lateral, 0.6 mm.

The medullary canal is full. Medullary index, 29%.

Structure.—The section is composed of lamellæ, concentrically arranged around the medullary canal. There are no radiating canals. The lamellæ are clear, their lacunæ oval, long and narrow, and their canaliculi are long and numerous. The section has a uniform structure.

The peculiar feature is the complete disappearance of the radiating canals.

These figures show drawings of femora taken from the same species of frogs, but of different sizes and weights. The largest (fig. 1) is lowest in development; the second in size (fig. 2) is next, and the third (fig. 3) is last and most complete. They are all of the first type, though of different developments. In figure 1 the radiating canals with poorly developed intervening lamellæ indicate an early stage of development. In figure 2 more than half of the canals have disappeared and better developed lamellæ are formed. In figure 3 all of the canals have disappeared and the whole bone is composed of concentric lamellæ.

Type I.

RIGHT FEMUR OF RANA CATESBIANA (SMALL). FOURTH BULL FROG. CR. MED. COLL.

PL. 1, FIG. 4. SYN. TAB. I

Antero-posterior diameter of bone, 1 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.6 mm.

Medullary index, 24%.

Structure.—The section is composed of concentric lamellæ with long lacunæ and long, straight canaliculi surrounding the medullary canal. The section has a uniform structure.

Type I.

FRACTURED AND REPAIRED FEMUR OF A FROG. CR. MED. COLL.

PL. 1, FIG. 5. SYN. TAB. I

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1.7 mm.

Antero-posterior diameter of medullary canal, 0.6 mm.; lateral, 0.7 mm.

The medullary canal is full. Medullary index, 20%.

Structure.—One of the femora had been fractured about the middle of the shaft. The ends of the bone had slipped by each other, and new bone had formed around the fragments. In section (fig. 5) which was taken from the middle of the new bone, two cuts of the femur appear situated eccentrically. The sections are composed of concentric lamellæ with oval and straight lacunæ surrounding the medullary canals.

The upper fragment, H, proximal, shows cell growths bursting through the wall of the bone (pl. 1, fig. 5, A, B). In the lower fragment, D, distal, no cell outbursts appear.

Around the two fragments and extending between them is a formation of cancellous or channeled bone which is the new bone of repair. Some of the meshes of this bone are occupied by newly deposited lamellæ, and resemble Haversian systems, although there are no Haversian systems or cancellous bone in the femur of the frog (pl. 1, fig. 5 C, E). This fact suggests a genetic relationship between cancellous bone and Haversian systems.

Type I.

RIGHT FEMUR OF AMBLYSTOMA TIGRINUM. AMER. MUS. NAT. HIS.

PL. 2, FIG. 6. SYN. TAB. I

Antero-posterior diameter of bone, 2 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, cancellous meshes.

Medullary index, 0.

Structure.—The section has no distinct medullary canal. It is composed of a narrow external ring of bone substance, with a few oval lacunæ and bushy canaliculi, from the under portion of which a cancellous center is derived. The meshes are filled with structureless material, and their walls have the same structure as the walls of the bone.

Type I.

RIGHT FEMUR OF HYLA VERSICOLOR. TREE FROG. AMER. MUS. NAT. HIST.

PL. 2, FIG. 7. SYN. TAB. I

Antero-posterior diameter of bone, 0.8 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.2 mm.; lateral, 0.2 mm.

The medullary canal is full. Medullary index, 7%.

Structure.—The entire section is composed of lamellæ with round and oval lacunæ and bushy canaliculi enclosing the medullary canal. The section has a uniform structure.

Type I.

RIGHT FEMUR OF HYLA ARENICOLOR. NO. E 50 30, U. S. NAT. MUS.

PL. 2. FIG. 8. SYN. TAB. I

Antero-posterior diameter of bone, 0.5 mm.; lateral, 0.5 mm.

Antero-posterior diameter of medullary canal, 0.2 mm.; lateral, 0.2 mm.

The medullary canal is full. Medullary index, 19%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and long, straight canaliculi, divided into wide external and narrow internal rings which surround its medullary canal, thus showing a twofold division.

Type I.

RIGHT FEMUR OF HYLA FEMORALIS. NO. E 60 23, U. S. NAT. MUS.

PL. 2, FIG. 9. SYN. TAB. I

Antero-posterior diameter of bone, 0.5 mm.; lateral, 0.4 mm.

Antero-posterior diameter of medullary canal, 0.2 mm.; lateral, 0.2 mm.

The medullary canal is full. Medullary index, 24%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and long canaliculi, divided into wide external and narrow internal rings which surround the medullary canal, a twofold division.

Type I.

RIGHT FEMUR OF HYLA EVITTATA. NO. E 55 17, U. S. NAT. MUS.

PL. 2, FIG. 10. SYN. TAB. I

Antero-posterior diameter of bone, 0.5 mm.; lateral, 0.2 mm.

Antero-posterior diameter of medullary canal, 0.4 mm.; lateral, 0.1 mm.

The medullary canal is full. Medullary index, 104%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and long canaliculi, divided into wide external and narrow internal concentric rings which surround the medullary canal, a twofold division.

Type I.

RIGHT FEMUR OF HYLA CINEREA. NO. 13095, U. S. NAT. MUS.

PL. 2, FIG. 11. SYN. TAB. I

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 14%.

Structure.—The section has a long posterior process, the central position of which, from the medullary canal to the tip, is occupied by bone substance with a few oval lacunæ and branching canaliculi. The body of the section is composed of lamellæ with oval lacunæ and straight canaliculi. A narrow ring of internal circumferential lamellæ surrounds the medullary canal. The section shows a twofold division.

Type I.

RIGHT FEMUR OF HYLA REGILLA. NO. E 62 39, U. S. NAT. MUS.

PL. 2, FIG. 12. SYN. TAB. I

Antero-posterior diameter of bone, 1 mm.; lateral, 0.9 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—The section is composed of lamellæ with oval lacunæ and long canaliculi, divided into wide external and narrow internal rings. The internal ring forms the internal circumferential lamellæ. Twofold division.

Type I.

RIGHT FEMUR OF HYLA SQUIRELLA. NO. E 51 2, U. S. NAT. MUS.

PL. 2, FIG. 13. SYN. TAB. I

Antero-posterior diameter of bone, 0.8 mm,; lateral, 0.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 92%.

Structure.—The section is triangular in shape and composed of lamellæ with round and oval lacunæ and long canaliculi, divided into wide external and narrow internal rings. A vascular canal is seen in the posterior wall. The internal ring forms the internal circumferential lamellæ. Twofold division.

Type I.

RIGHT FEMUR OF HYLA GRATIOSA. NO. E 40 14, U. S. NAT. MUS.

PL. 2. FIG. 14. SYN. TAB. I

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 44%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi surrounding the medullary canal. A narrow lamina, not parallel with the external or medullary surfaces, forms a complete ring around the section. It approaches the medullary surface in the lateral wall and departs from it in the anterior and posterior wall.

Type I-II

RIGHT FEMUR OF DENDROBATES TINCTORIUS. NO. E 14 36, U. S. NAT. MUS.

PL. 2. FIG. 15. SYN. TAB. I

Antero-posterior diameter of bone, 0.6 mm.; lateral, 0.5 mm.

Antero-posterior diameter of medullary canal, 0.2 mm.; lateral, 0.2 mm.

The medullary canal is full. Medullary index, 15%.

Structure.—The section is composed of lamellæ with long, narrow lacunæ and long, straight canaliculi, divided into wide external and narrow internal rings. The internal ring forms the internal circumferential lamellæ. Twofold division.

Type I.

RIGHT FEMUR OF LEPTODACTYLUS ALBILABRIS. G 13 11, U. S. NAT. MUS.

PL. 2, FIG. 16. SYN. TAB. I

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.8 mm.; lateral, 0.3 mm.

The medullary canal is full. Medullary index, 59%.

Structure.—The section is composed of lamellæ with oval lacunæ and straight canaliculi, divided into wide external and narrow internal rings. The internal ring forms the internal circumferential lamellæ. Twofold division.

Type I.

RIGHT FEMUR OF CHOROPHILUS FERIARUM. NO. E 52 47, U. S. NAT. MUS.

PL. 2, FIG. 17. SYN. TAB. I

Antero-posterior diameter of bone, 0.5 mm.; lateral, 0.4 mm.

Antero-posterior diameter of medullary canal, 0.2 mm.; lateral, 0.2 mm.

The medullary canal is full. Medullary index, 24%.

Structure.—The section is composed of lamellæ with oval lacunæ and straight canaliculi, divided into wide external and narrow internal rings. The internal ring forms the internal circumferential lamellæ. Twofold division.

Type I.

RIGHT FEMUR OF ACRIS GRYLLUS. U. S. NAT. MUS.

PL. 2, FIG. 18. SYN. TAB. I

Antero-posterior diameter of bone, 0.5 mm.; lateral, 0.3 mm.

Antero-posterior diameter of medullary canal, 0.2 mm.; lateral, 0.1 mm.

The medullary canal is full. Medullary index, 16%.

Structure.—The section is composed of lamellæ with oval lacunæ and straight canaliculi, divided into wide external and narrow internal rings. The internal ring forms the internal circumferential lamellæ. Twofold division.

Type I.

RIGHT FEMUR OF RANA CATESBIANA. BULL FROG. AMER. MUS. NAT. HIST.

PL. 2, FIG. 19. SYN. TAB. I

Antero-posterior diameter of bone, 2.5 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm,; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of lamellæ with round, oval, and long lacunæ and straight, long, thickly set canaliculi, arranged concentrically around the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF RANA PALUSTRIS. NO. F 52 22, U. S. NAT. MUS.

PL. 2, FIG. 20. SYN. TAB. I

Antero-posterior diameter of bone, 1 mm,; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 44%.

Structure.—The section is composed of concentric lamellæ with round and oval lacunæ and bushy canaliculi, separated into two concentric rings. The positions of the lacunæ and canaliculi give a radiating effect. The internal ring forms the internal circumferential lamellæ. Twofold division.

Type I.

RIGHT FEMUR OF RANA AREOLATA CIRCULOSA. NO. F 72 3, U. S. NAT. MUS.

PL. 2, FIG. 21. SYN. TAB. I

Antero-posterior diameter of bone, 2 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1.4 mm.

The medullary canal is full. Medullary index, 110%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi surrounding the medullary canal. The bone is uniform in structure. A portion of the nutrient canal is seen.

Type I.

RIGHT FEMUR OF RANA AGILIS AURORA. NO. F 50 10, U. S. NAT. MUS.

PL. 2, FIG. 22. SYN. TAB. I

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 19%.

Structure.—The section is composed of lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal, and divided into dim, wide external and narrow internal rings. Twofold division.

Type I.

RIGHT FEMUR OF RANA PRETIOSA. NO. F 75 11, U. S. NAT. MUS.

PL. 2. FIG. 23. SYN. TAB. I

Antero-posterior diameter of bone, 2 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 0.8 mm.

The medullary canal is full. Medullary index, 41%.

Structure.—The section is composed of lamellæ with round and oval lacunæ and bushy canaliculi, dimly separated into four or five concentric divisions. In some portions of the section a few radiating canals are seen.

Type I.

RIGHT FEMUR OF RANA DRAYTONII. NO. F 70 14, U. S. NAT. MUS.

PL. 2, FIG. 24. SYN. TAB. I

Antero-posterior diameter of bone, 3 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1.5 mm.

The medullary canal is full and eccentrically situated. Medullary index, 33%.

Structure.—The section is composed of lamellæ with round and oval lacunæ and bushy canaliculi surrounding the medullary canal. The lacunæ are generally arranged in concentric rows and their bushy canaliculi extend outward from them. The canaliculi frequently unite and form a fine network. In some parts of the section there are large radiating canals extending the whole width of the walls of the bone. These canals communicate with adjacent lacunæ by fine canaliculi. The section as a whole has a bushy appearance. The large radiating canals seem to be found only in the frogs of large size.

Type I.

RIGHT FEMUR OF SPELERPES RUBER. RED SALAMANDER. AMER. MUS. NAT. HIST.

PL. 2, FIG. 25. SYN. TAB. I

Antero-posterior diameter of bone, 1 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.3 mm.; lateral, 0.2 mm.

The medullary canal is full. Medullary index, 4%.

Structure.—The entire section is composed of lamellæ with elongated lacunæ and bushy canaliculi enclosing the medullary canal. The bone has a uniform structure.

Type I.

RIGHT FEMUR OF CRYPTOBRANCHUS ALLEGHENIENSIS. HELLBENDER. AMER. MUS. NAT. HIST.

PL. 2, FIG. 26. SYN. TAB. I

Antero-posterior diameter of bone, 2.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 7%.

Structure.—With the exception of a few lamellæ around the medullary canal the entire section is composed of round and oval lacunæ with bushy canaliculi embedded in bone substance and arranged concentrically around the medullary canal. The medullary canal is relatively small. A slight structural differentiation appears in the lamellæ around the medullary canal. Twofold division.

Type I.

RIGHT FEMUR OF NECTURUS MACULATUS. AMER. MUS. NAT. HIST.

PL. 2, FIG. 27. SYN. TAB. I

Antero-posterior diameter of bone, 2 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 9%.

Structure.—Around the section are a few enclosing lamellæ with rather long lacunæ. Nearly the entire section is composed of large, oval, round, and elongated lacunæ with bushy canaliculi arranged radially between enclosing lamellæ. The arrangement of the lacunæ is such as to give a radiating appearance. Around the medullary canal are a few lamellæ with long lacunæ and long and straight canaliculi. Threefold division.

Type I.

RIGHT FEMUR OF SCAPHIOPUS HOLBROOKII. SPADEFOOT TOAD. AMER. MUS. NAT. HIST.

PL. 2. FIG. 28. SYN. TAB. I

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 11%.

Structure.—The section is composed of two divisions, one, external, composed of concentric lamellæ with round and oval lacunæ and long, straight canaliculi, and the other, internal, composed of circumferential lamellæ with long, narrow lacunæ and long, straight canaliculi. Twofold division.

Type I.

RIGHT FEMUR OF SCAPHIOPUS COUCHII. NO. F 50 20, U. S. NAT. MUS.

PL. 2. FIG. 29. SYN. TAB. I

Antero-posterior diameter of bone, 1 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.6 mm.

Medullary canal is full. Medullary index, 24%.

Structure.—The section is composed of lamellæ with long lacunæ and bushy canaliculi, indistinctly divided into concentric rings which surround the medullary canal.

Type I.

RIGHT FEMUR OF SCAPHIOPUS HAMMONDII. NO. F 20 6, U. S. NAT. MUS.

PL. 2. FIG. 30. SYN. TAB. I

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric rings of lamellæ surrounding a central medullary canal. The lacunæ are oval and the canaliculi are long.

Type I.

RIGHT FEMUR OF PIPA AMERICANA. SURINAM TOAD. AMER. MUS. NAT. HIST.

PL. 3. FIG. 31. SYN. TAB. I

Antero-posterior diameter of bone, 3.5 mm.; lateral, 5.5 mm.

Antero-posterior diameter of medullary canal, 0.8 mm.; lateral, 0.8 mm.

The medullary canal is full. Medullary index, 3%.

Structure.—The section is surrounded by a wide ring of lamellæ with long lacunæ and rather infrequent bushy canaliculi, interrupted by Haversian canals of the (Ia) differentiation. The ring is widest in the lateral walls. The canals appear in cross and oblique sections. Underneath this ring is a wide, central ring composed of crude lamellæ with oval lacunæ and relatively few canaliculi, enclosing large, irregularly shaped canals with surrounding, clear areas and presenting a general concentric arrangement. A few internal circumferential lamellæ with long lacunæ surround the medullary canal. Two large, open, round spaces appear, one in the inner posterior wall and the other in the outer lateral wall. The femur shows the three usual divisions—external circumferential lamellæ, central ring, internal circumferential lamellæ and primitive Haversian canals—all of which indicate slight advancement. Structural differentiation is shown by the three divisions and primitive Haversian canals.

Type I-III, Ia.

RIGHT FEMUR OF BUFO AGUA. BERMUDA TOAD. NO. 1113, AMER. MUS. NAT. HIST.

PL. 3, FIG. 32. SYN. TAB. I

Antero-posterior diameter of bone, 5 mm.; lateral, 3.5 mm.

Antero-posterior diameter of medullary canal, 2.5 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 39%.

Structure.—The section is surrounded by a wide band of bone substance with long, obliquely arranged lacunæ and straight canaliculi, interrupted by round, oval, and elongated filled canals around which are clear areas (Ia, differentiation). Underneath this band is a wide central ring of lamellæ with oval lacunæ and bushy canaliculi, interrupted by elongated and oval-filled canals surrounded by clear areas of bone substance (Ia, differentiation). Fine canaliculi pass from these canals to adjacent lacunæ. The canals mark the beginning of Haversian systems. Around the medullary canal is a narrow ring of lamellæ with oval lacunæ and bushy canaliculi. Threefold division.

Type I-III, Ia.

RIGHT FEMUR OF BUFO HALOPHILUS. NO. E 35 8, U. S. NAT. MUS.

PL. 3, FIG. 33. SYN. TAB. I

Antero-posterior diameter of bone, 2 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 129%.

Structure.—The structure shows the three divisions. The external circumferential lamellæ form a narrow boundary ring. The central ring constitutes most all of the section, and is composed of lamellæ with oval lacunæ and bushy canaliculi. In the anterior and posterior walls the ring is traversed by

Haversian canals of the (Ia) differentiation. Internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-III, Ia.

RIGHT FEMUR OF BUFO COLUMBIENSIS. NO. E 40, U. S. NAT. MUS.

PL. 3, FIG. 34. SYN. TAB. I

Antero-posterior diameter of bone, 2 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 1.4 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 111%.

Structure.—The section shows the three divisions, external circumferential lamellæ very thin, central ring of lamellæ, and internal circumferential lamellæ. The external lamellæ are little more than a condensation of the external portion of the central ring. The central ring consists of concentric lamellæ with oval lacunæ. In the posterior and part of the lateral walls, oval lacunæ with bushy canaliculi are crowded together between the central ring and internal lamellæ. A few canals appear in the inner wall. The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-III, Ia.

RIGHT FEMUR OF BUFO LENTIGINOSUS WOODHOUSII. NO. E 45 9, U. S. NAT. MUS.

PL. 3, FIG. 35. SYN. TAB. I

Antero-posterior diameter of bone, 2.5 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—The section is composed of a thick ring of concentric lamellæ with oval lacunæ, crossed by numerous radiating canals and perforated by a few Haversian canals (Ia). Internal circumferential lamellæ form a narrow ring around the medullary canal. Twofold division.

Type I-III, Ia.

RIGHT FEMUR OF BUFO AMERICANUS. AMERICAN TOAD. AMER. MUS. NAT. HIST.

PL. 3, FIG. 36. SYN. TAB. I

Antero-posterior diameter of bone, 2.5 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 0.6 mm.

The medullary canal is full. Medullary index, 15%.

Structure.—The section is surrounded by a wide band of lamellæ with oval lacunæ and bushy canaliculi, interrupted by frequent Haversian canals of the (Ia) differentiation. The band is widest in the anterior and inner walls.

Underneath this band is a single lamina with long, well-developed lacunæ and straight canaliculi, parallel with neither surface of the bone, but occupying an irregular position.

Underneath the lamina is a wide central ring of lamellæ with oval lacunæ and bushy canaliculi, interrupted by frequent Haversian canals of the (Ia) differentiation. A narrow ring of internal circumferential lamellæ surrounds the medullary canal. Threefold division.

Type I-II-III, Ia.

RIGHT FEMUR OF BUFO LENTIGINOSUS COGNATUS. NO. 13 11, U. S. NAT. MUS.

PL. 3, FIG. 37. SYN. TAB. I

Antero-posterior diameter of bone, 2 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 0.9 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—The three divisions are evident. The external circumferential lamellæ, with long lacunæ and straight canaliculi, surround the section. The central ring is composed of lamellæ with oval lacunæ perforated by Haversian canals of the (Ia) differentiation. The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-III, Ia.

RIGHT FEMUR OF BUFO VALLICEPS. NO. E 21 5, U. S. NAT. MUS.

PL. 3, FIG. 38. SYN. TAB. I

Antero-posterior diameter of bone, 2 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.9 mm.; lateral, 0.8 mm.

The medullary canal is full. Medullary index, 31%.

Structure.—The section is surrounded by a thick band of lamellæ with oval lacunæ and bushy canaliculi. It is perforated by numerous Haversian canals of the (Ia) differentiation. In the inner wall many radiating canals appear. The canaliculi from adjacent lacunæ extend into both the circular and radiating canals. A narrow ring of internal circumferential lamellæ encloses the medullary canal. Twofold division.

Type I-III, Ia.

RIGHT FEMUR OF RANA BOYLII. NO. F 61 20, U. S. NAT. MUS.

PL. 3, FIG. 39. SYN. TAB. I

Antero-posterior diameter of bone, 1 mm.; lateral, 0.6 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 47%.

Structure.—The section is composed of two parts, viz.: A wide ring of external lamellæ with oval lacunæ and bushy canaliculi, and a narrow ring of internal lamellæ with long, narrow lacunæ and straight canaliculi around the medullary canal. Twofold division.

Type I.

VII. REPTILES

Thirty-four femora were examined.

General Character of the Femur

The general shape of the reptilian femur varies considerably. The triangular, elliptical, round, and indeterminate forms are present. The majority are elliptical. In some sections the antero-posterior diameters are longest, as in many of the lizards, and in others the lateral diameters are longest, as in the turtles.

The contents of the medullary canals are variable in character. In the lizards they are filled with marrow and in the turtle with cancellous bone, the meshes of which are filled with marrow.

The medullary surfaces are smooth in the small, and rough in the large, femora.

The medullary index varies from 0 to 88% with an average of 26.1%. Excluding the turtles, in most of which the index is zero, the average is 33%.

The reptilian femora follow about the same kind of development as was seen in the amphibians, but the development is carried further.

The first type of bone predominates in both amphibians and reptiles. Haversian canals, (Ia) stage, appear in the amphibians, while a better developed form of Haversian system, (Ib) stage, is found in some of the reptiles. In the amphibians the external, internal circumferential lamellæ, and central ring appear, while in the reptiles these divisions are not prominent. Cancellous bone was found in one amphibian, the Amblystoma. It does not appear in the lizards, and is a characteristic structure of turtles.

Detailed Examination

RIGHT FEMUR OF SPHENODON PUNCTATA (MOST PRIMITIVE OF REPTILES). AMER. MUS. NAT. HIST.

Pl. 3, Fig. 40. Syn. Tab. II

Antero-posterior diameter of bone, 3 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 26%.

Structure.—The section is composed entirely of concentric lamellæ with oval lacunæ and bushy canaliculi surrounding the medullary canal. A large vascular canal appears in the inner and posterior wall. There is very little differentiation of structure. The bone is uniform.

Type I.

RIGHT FEMUR OF PHRYNOSOMA CORNUTUM. TEXAS HORNED TOAD. NO. 1200, AMER. MUS. NAT. HIST.

PL. 3, FIG. 41. SYN. TAB. II

Antero-posterior diameter of bone, 2.8 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.8 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 10%.

Structure.—The section is composed of concentric lamellæ with long and oval lacunæ and straight and bushy canaliculi surrounding the medullary canal. The lacunæ of the external portion are long and narrow with straight canaliculi, and those of the medullary portion are oval with bushy canaliculi. There is very little differentiation of structure. The section shows an indistinct twofold division.

Type I.

LEFT FEMUR OF CHAMÆLEO VULGARIS. CHAMELEON. NO. 135, AMER. MUS. NAT. HIST.

PL. 3, FIG. 42. SYN. TAB. II

Antero-posterior diameter of bone, 1.8 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 0.8 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—The section is composed of an external ring of lamellæ with oval lacunæ and bushy canaliculi. The lacunæ tend to flatten as they reach the external surface. In the posterior wall the lacunæ are large and nearly round. Underneath this ring is another of lamellæ with oval lacunæ and bushy canaliculi. The two rings are separated by concentric, central lacunæ closely packed together. The bone shows an indistinct twofold division.

Type I.

RIGHT FEMUR OF PHRYNOSOMA DOUGLASSII. NO. L 50 12, U. S. NAT. MUS.

PL. 3, FIG. 43. SYN. TAB. II

Antero-posterior diameter of bone, 2 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 12%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and long canaliculi surrounding the medullary canal. Little or no differentiation has occurred. The section has a uniform structure.

Type I.

RIGHT FEMUR OF PTYCHOZOON HOMALOCEPHALUM—GECKO. NO. 684 AMER. MUS. NAT. HIST.

PL. 3, FIG. 44. SYN. TAB. II

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with long lacunæ and long, straight canaliculi surrounding the medullary canal. Very little differentiation appears. The section is uniform.

Type I.

RIGHT FEMUR OF IGUANA TUBERCULATA. AMER. MUS. NAT. HIST.

PL. 3. FIG. 45. SYN. TAB. II

Antero-posterior diameter of bone, 3.5 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 2 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 61%.

Structure.—The section is composed of concentric lamellæ with long lacunæ and long, straight canaliculi surrounding the medullary canal. The posterior wall is thickest and shows a column of oval lacunæ and their lamellæ extending from the medullary canal toward the external posterior surface. Very little differentiation of structure appears. The section is uniform.

Type I.

LEFT FEMUR OF VARANUS SALVATOR. AMER. MUS. NAT. HIST.

PL. 3. FIG. 46. SYN. TAB. II

Antero-posterior diameter of bone, 11 mm.; lateral, 10 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 51%.

Structure.—The section is composed of concentric lamellæ with long and oval lacunæ and bushy canaliculi surrounding the bone, with the exception of the posterior wall. The lamellæ are partially separated into laminæ by concentric rows of long lacunæ placed end to end. Numerous short canals, parallel to each other and radiating from the medullary canal, cross the lamellæ. Around the canals are clear areas of bone substance crossed in many instances by fine canaliculi. In the posterior and inner wall the concentric lamellæ are displaced by canals and oval lacunæ with bushy canaliculi extending from the external surface to the medullary canal. The canals mark the locations of future Haversian systems. Fragments of lamellæ surround the medullary canal. In the posterior wall a little cancellous bone appears. The bone shows an early differentiation by its traces of laminæ and Haversian canals.

Type I-III, Ia.

RIGHT FEMUR OF AMPHIBOLURUS BARBATUS. (AUSTRALIA.)
AMER. MUS. NAT. HIST.

PL. 3, FIG. 47. SYN. TAB. II

Antero-posterior diameter of bone, 3 mm.; lateral, 4 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 49%.

Structure.—The section is composed of concentric lamellæ with long and oval lacunæ and long, straight canaliculi surrounding the medullary canal. No differentiation of structure is present. A large, vascular canal appears in the inner wall. The section is uniform.

Type I.

LEFT FEMUR OF VARANUS ARENARIUS. AMER. MUS. NAT. HIST.

PL. 3, FIG. 48. SYN. TAB. II

Antero-posterior diameter of bone, 4.5 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi arranged around the medullary canal. Many small canals traverse the walls of the bone radially from the medullary canal outward and from the external surface inward. There is very little differentiation of structure. The section is uniform.

Type I.

RIGHT FEMUR OF VARANUS NUCHALIS. MONITOR. AMER. MUS. NAT. HIST.

PL. 3, FIG. 49. SYN. TAB. II

Antero-posterior diameter of bone, 4.5 mm.; lateral, 3.5 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 88%.

Structure.—With the exception of a small area of lamellæ along the medullary surface of the posterior wall, the section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi, interrupted by a large number of short, radiating canals around which are clear areas of bone substance. In the posterior wall the canals are circular in cross-section, elsewhere they are long. The bone shows a little differentiation of structure.

Type I-III, Ia.

RIGHT FEMUR OF HELODERMA SUSPECTUM. GILA MONSTER. NO. 583, AMER. MUS. NAT. HIST.

PL. 4, FIG. 50. SYN. TAB. II

Antero-posterior diameter of bone, 3 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 0.7 mm.; lateral, 0.7 mm.

The medullary canal is full. Medullary index, 5%.

Structure.—The section is composed of concentric lamellæ having oval and long lacunæ with bushy and straight canaliculi indistinctly outlined in laminæ. The external lamellæ show long lacunæ and rather straight canaliculi, the remaining lamellæ, oval lacunæ and bushy canaliculi. Around the medullary canal is an enclosing ring of lamellæ with lacunæ and long, straight canaliculi. The bone shows traces of differentiation into the three main divisions —external, a central ring, and internal circumferential lamellæ. There is no trace of an Haversian system.

Type I.

RIGHT FEMUR OF SCELOPORUS CLARKII. NO. I 61 17, U. S. NAT. MUS.

PL. 4, FIG. 51. SYN. TAB. II

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 12%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi surrounding the medullary canal. There is no differentiation of structure. The section is uniform.

Type I.

RIGHT FEMUR OF SCELOPORUS SPINOSUS FLORIDANUS. NO. I 73 12, U. S. NAT. MUS.

PL. 4. FIG. 52. SYN. TAB. II

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 12%.

Structure.—The section is composed of concentric lamellæ with long lacunæ and straight canaliculi surrounding the medullary canal. There is no differentiation of structure. The section is uniform.

Type I.

RIGHT FEMUR OF SCELOPORUS OCCIDENTALIS. NO. I 74 3, U. S. NAT. MUS.

PL. 4. FIG. 53. SYN. TAB. II

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.6 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 24%.

Structure.—The section is composed of lamellæ with oval and long lacunæ and straight canaliculi surrounding the medullary canal. There is no differentiation of structure.

Type I.

RIGHT FEMUR OF SCELOPORUS MAGISTER. NO. J 71 2, U. S. NAT. MUS.

PL. 4. FIG. 54. SYN. TAB. II

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 19%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi surrounding the medullary canal. There is no differentiation of structure.

Type I.

RIGHT FEMUR OF CYCLURA CARINATA. U. S. NAT. MUS.

PL. 4. FIG. 55. SYN. TAB. II

Antero-posterior diameter of bone, 5 mm.; lateral, 5 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 3 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. There is very little differentiation of structure. The section is uniform.

Type I.

RIGHT FEMUR OF ANOLIS CRISTATELLUS. NO. L 15 13, U. S. NAT. MUS.

PL. 4. FIG. 56. SYN. TAB. II

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of two rings of lamellæ, external and internal. The external has long lacunæ with straight canaliculi and the internal, oval and round lacunæ with bushy canaliculi. They are of nearly equal width. There is very little differentiation of structure. The section shows the twofold division.

Type I.

RIGHT FEMUR OF CROTAPHYTUS COLLARIS. NO. J 21 12, U. S. NAT. MUS.

PL. 4, FIG. 57. SYN. TAB. II

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 80%.

Structure.—The section is composed of two concentric rings of lamellæ surrounding the medullary canal. The external ring has long lacunæ and straight canaliculi, the internal, oval lacunæ and bushy canaliculi. The section shows the twofold division.

Type I.

LEFT FEMUR OF CROTAPHYTUS COLLARIS. NO. J 32 9, U. S. NAT. MUS.

PL. 4, FIG. 58. SYN. TAB. II

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.8 mm.; lateral, 0.8 mm.

The medullary canal is full. Medullary index, 40%.

Structure.—The section is composed of two concentric rings of lamellæ surrounding the medullary canal. The external has long lacunæ and straight canaliculi, the internal, oval lacunæ and bushy canaliculi. The section shows the twofold division.

Type I.

RIGHT FEMUR OF AMEIVA EXUL. (CAYA DE SANTIAGO, PORTO RICO.) NO. L 21 11, U. S. NAT. MUS.

PL. 4. FIG. 59. SYN. TAB. II

Antero-posterior diameter of bone, 2 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index. 33%.

Structure.—The section is composed of concentric lamellæ with oval and long lacunæ and straight canaliculi surrounding the medullary canal. There is very little differentiation of structure. The section is uniform.

Type I.

RIGHT FEMUR OF EUMECES FASCIATUS. NO. H 31 4, U. S. NAT. MUS.

PL. 4. FIG. 60. SYN. TAB. II

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.6 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 24%.

Structure.—The section is composed of lamellæ with oval lacunæ and bushy canaliculi dimly outlined in laminæ. There is little differentiation of structure.

Type I.

RIGHT FEMUR OF SAUROMALUS. NO. J 40 6, U. S. NAT. MUS.

PL. 4, FIG. 61. SYN. TAB. II

Antero-posterior diameter of bone, 3 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1.2 mm.

The medullary canal is full. Medullary index, 32%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi partially divided into concentric rings. A vascular canal is seen in the posterior inner wall. A narrow ring of lamellæ with long lacunæ and straight canaliculi surrounds the medullary canal.

Type I.

RIGHT FEMUR OF GERRHONOTUS GRANDIS. NO. I 22 4, U. S. NAT. MUS.

PL. 4, FIG. 62. SYN. TAB. II

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.4 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 11%.

Structure.—The section is composed of concentric lamellæ with oval and long lacunæ and straight and bushy canaliculi. Around the posterior and lateral medullary surface is a crescent of basic bone substance with round lacunæ and bushy canaliculi.

Type I.

RIGHT FEMUR OF PYTHON REGIUS. PYTHON. (11½ FEET IN LENGTH—DIED AT WASHINGTON ZOO)

PL. 4, FIG. 63. SYN. TAB. II

Antero-posterior diameter of bone, 1 mm.; lateral, 0.6 mm.

Antero-posterior diameter of medullary canal, 0.4 mm.; lateral, 0.3 mm.

The medullary canal is full. Medullary index, 24%.

Structure.—The femur is rudimentary. The section is composed of lamellæ arranged in a peculiar manner. In the anterior wall they are arranged concentrically around a semicircle with a short radius. In the lateral and posterior wall the lamellæ take a long curve from the medullary surface of the anterior wall. The lacunæ are round and the canaliculi are bushy. The anterior wall is best developed. A narrow ring of internal lamellæ with long lacunæ and straight canaliculi surrounds the medullary canal.

Type I.

LEFT FEMUR OF THE SAME PYTHON REGIUS. U. S. NAT. MUS.

PL. 4, FIG. 64. SYN. TAB. II

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 28%.

Structure.—The section is composed of two rings of lamellæ, viz.: external and internal. The external is thickest and is composed of lamellæ with a few round and oval lacunæ and bushy canaliculi. The canaliculi of the posterior wall are long and straight and, in the anterior wall, infrequent and bushy. A narrow ring of internal lamellæ with long lacunæ and straight canaliculi surrounds the medullary canal.

Type I.

LEFT FEMUR OF ALLIGATOR MISSISSIPPIENSIS. ALLIGATOR. CR. MED. COLL.

PL. 4, FIG. 65. SYN. TAB. II

Antero-posterior diameter of bone, 17 mm.; lateral, 15 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 20%.

Structure.—A thin cross-section of this femur held up to the light presents a ringed appearance like that of a cross-section of the trunk of a tree.

The section is composed of three concentric rings of laminæ with long, narrow lacunæ and straight canaliculi, alternating with four concentric rings of bone substance enclosing crude Haversian canals. The Haversian canals are round, oval, or irregular in shape, are large and small in size, and very numerous. They are surrounded by clear areas of bone substance and many fine canaliculi from concentric adjacent oval lacunæ pass radially across the areas of bone substance into the canals. The (Ib) stage of the Haversian system is represented. The laminæ are fairly well developed.

Type I-II-III, Ia, Ib.

FEMUR OF CHELYDRA SERPENTINA. SNAPPING TURTLE. CR. MED. COLL.

PL. 4, FIG. 66. SYN. TAB. II

Antero-posterior diameter of bone, 8 mm.; lateral, 8.5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 1.5%.

Structure.—The wall of the shaft is very thick, proportionately, and the medullary canal is very small. The femur is nearly solid. The section has four concentric rings of laminæ alternating with three concentric rings of bone substance in which are many Haversian canals. The canals are much more regular in shape than they were in the alligator and are surrounded by smaller, clear areas of bone substance. Oval lacunæ are arranged concentrically around the boundaries of these areas and bushy canaliculi pass from the lacunæ to the canals. The laminæ are much better developed than the Haversian systems which have reached the (Ib) differentiation. The posterior wall is composed of bone substance with round lacunæ and bushy canaliculi arranged as a crude cancellous bone and merges into the cancellous bone of the medullary canal.

Type I-II-III, Ia, Ib.

RIGHT FEMUR OF TRIONYX SPINIFER. SOFT-SHELLED TURTLE. NO. 2325, AMER. MUS. NAT. HIST.

PL. 4, FIG. 67. SYN. TAB. II

Antero-posterior diameter of bone, 3.5 mm.; lateral, 5.5 mm.

Antero-posterior diameter of medullary canal—cancellous bone.

The medullary canal is full. Medullary index, 0.

Structure.—The section is surrounded by a ring of lamellæ with oval lacunæ and bushy canaliculi. It is interrupted by Haversian canals of the (Ia) differentiation. In the posterior wall here and there an Haversian system appears in the (Ib) stage of advancement. Cancellous bone occupies the central canal of the bone and is derived, by extension, from the enclosing lamellar ring. The walls of the cancellous meshes are composed of lamellæ with oval and long lacunæ and straight canaliculi. There is no individual medullary canal.

Type I-III, Ia, Ib.

RIGHT FEMUR OF CINOSTERNUM PENNSYLVANICUM. MUD TURTLE. AMER. MUS. NAT. HIST.

PL. 4, FIG. 68. SYN. TAB. II

Antero-posterior diameter of bone, 3 mm.; lateral, 3.5 mm.

Antero-posterior diameter of medullary canal—cancellous bone.

The medullary canal is full. Medullary index, 0.

Structure.—The section is surrounded by a narrow ring of lamellæ with oval lacunæ and bushy canaliculi, from which is derived the cancellous bone which fills the medullary canal. A few Haversian systems of the (Ib) differentiation are found in the posterior wall.

Type I-III, Ib.

RIGHT FEMUR OF CHELOPUS GUTTATUS. SPOTTED TURTLE. AMER. MUS. NAT. HIST.

PL. 4, FIG. 69. SYN. TAB. II

Antero-posterior diameter of bone, 2.5 mm.; lateral, 4 mm.

Antero-posterior diameter of medullary canal—cancellous bone.

The medullary canal is full. Medullary index, 0.

Structure.—The section is surrounded by a narrow ring of lamellæ with oval lacunæ and bushy canaliculi, interrupted by a few Haversian canals of the (Ia) differentiation. From the under surface of this ring is derived a cancellous bone which entirely fills the medullary canal. The walls of the meshes are composed of lamellæ with oval lacunæ and bushy canaliculi. In the posterior wall are a few Haversian systems of the (Ib) stage of development.

Type I-III, Ia, Ib.

LEFT FEMUR OF CHRYSEMYS PICTA. PAINTED TURTLE. AMER. MUS. NAT. HIST.

PL. 4, FIG. 70. SYN. TAB. II

Antero-posterior diameter of bone, 2.5 mm.; lateral, 4 mm.

Antero-posterior diameter of medullary canal—cancellous bone.

The medullary canal is full. Medullary index, 0.

Structure.—The section is surrounded by a ring of lamellæ with oval lacunæ and bushy canaliculi, interrupted by a few Haversian canals of the (Ia) differentiation. Haversian systems of the (Ib) stage of development are found in the posterior wall. From the lamellar ring is derived the cancellous bone which occupies the whole medullary canal.

Type I-III, Ia, Ib.

RIGHT FEMUR OF AROMOCHELYS ODORATUS. MUSK TURTLE. AMER. MUS. NAT. HIST.

PL. 4, FIG. 71. SYN. TAB. II

Antero-posterior diameter of bone, 1.8 mm.; lateral, 1.4 mm.

Antero-posterior diameter of medullary canal, 0.3 mm.; lateral, 0.3 mm.

The medullary canal is full. Medullary index, 4%.

Structure.—The section is surrounded by a band of lamellæ of various widths. The lacunæ are long and their canaliculi are long and straight. Underneath this is a central ring of lamellæ with oval lacunæ and bushy canaliculi. In this ring are several Haversian systems of the (Ib) differentiation forming a circular row around the medullary canal.

Around the medullary canal is a ring of internal circumferential lamellæ with long lacunæ and straight canaliculi. The bone shows the outlines of the three divisions—external and internal circumferential lamellæ and the central ring of lamellæ with Haversian systems.

Type I-III, Ib.

RIGHT FEMUR OF PSEUDEMYS FLORIDANA. NO. 28417, U. S. NAT. MUS.

PL. 4, FIG. 72. SYN. TAB. II

Antero-posterior diameter of bone, 4 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal—cancellous bone.

Medullary index, 0.

Structure.—The section is composed of lamellæ with oval lacunæ and bushy canaliculi, incompletely separated into laminæ which surround the medullary canal. In the posterior wall the crude laminæ are frequently interrupted by Haversian canals of the (Ib) differentiation. In the internal laminæ of the anterior wall are several crude undeveloped and a few fairly well developed Haversian systems. The medullary canal is occupied by cancellous bone.

Type I-II-III, Ib.

RIGHT FEMUR OF TESTUDO (GOPHERUS) POLYPHEMUS. NO. 7555, U. S. NAT. MUS.

PL. 4, FIG. 73. SYN. TAB. II

Antero-posterior diameter of bone, 8.5 mm.; lateral, 6 mm.

Antero-posterior diameter of medullary canal—cancellous bone.

The medullary canal is full. Medullary index, 0.

Structure.—The section is composed of incompletely formed, concentric laminæ which constitute the anterior, outer, and posterior wall. The laminæ are crossed by short, radiating canals and interrupted by Haversian systems of the (Ia) differentiation. Beneath the laminæ of the anterior and outer wall are Haversian systems of the (Ib) stage of development and the posterior ridge is made up almost entirely of Haversian systems of the same development. The inner wall is composed of lamellæ.

Type I-III, Ia, Ib.

VIII. BIRDS

Forty femora were examined.

General Character of the Femur

The femora of birds vary considerably in shape. A few are triangular, many are elliptical, and some are circular. The majority of them are elliptical and their antero-posterior diameters are longest. The medullary contents present a variable character. In some femora the medullary canals are full of marrow; in some, of cancellous bone, the meshes of which are filled with marrow; while in others, the canals are empty or occupied by trabeculæ only. About half of the femora examined have no contents.

The medullary surfaces also vary somewhat in character. In those canals filled with marrow and blood vessels the surface is uneven, while in those which have no contents the surface is smooth. In these bones the walls are thin, the canals large, and the trabeculæ are numerous. The medullary index varies from 0 to 327%, with an average of 159%.

The bone structures show considerable variation. The three single types and many combinations of types, in an incomplete or complete differentiation, are found. None of these, with the possible exception of the first, have reached their full development. The second is found in a very incomplete and an advanced stage and forms the structure of a large number of femora; while the third has assumed a more complex form than that found in reptiles. The Haversian systems are comparatively large, the Haversian canals are small and around them are concentrically arranged round or oval lacunæ with intricate networks of canaliculi. This is the (Ic) stage of Haversian differentiation and is characteristic of birds.

Detailed Examination

RIGHT FEMUR OF CYANOCITTA STELLERI AZTECA. AZTEC JAY. NO. 2874, AMER. MUS. NAT. HIST.

Pl. 5, Fig. 74. Syn. Tab. III

Antero-posterior diameter of bone, 3 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 2 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 68%.

Structure.—The section is composed of bone substance with oval lacunæ and bushy canaliculi surrounding the medullary canal. The bone substance is partially separated into laminæ by short canals. The bone shows but little differentiation of structure.

Type I-II.

LEFT FEMUR OF MERGUS SERRATOR. RED-BREASTED MERGANSER. NO. 3117, AMER. MUS. NAT. HIST.

Pl. 5, Fig. 75. Syn. Tab. III

Antero-posterior diameter of bone, 6.5 mm.; lateral, 4.5 mm.

Antero-posterior diameter of medullary canal, 4.5 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 68%.

Structure.—The section is composed of bone substance with oval lacunæ and bushy canaliculi, separated into incomplete laminæ by short, concentric, branching canals. A few vascular canals running longitudinally appear in the posterior inner and anterior wall. In the bone substance are a few Haversian systems of the (Ic) stage of development, and a single better differentiated system occurs in the tip of the posterior ridge. The lacunæ are oval. A narrow ring of internal circumferential lamellæ with long lacunæ and straight canaliculi surrounds the medullary canal.

Type I-II-III, Ic.

RIGHT FEMUR OF AJAIA AJAJA. ROSEATE SPOONBILL. NO. 2858, AMER. MUS. NAT. HIST.

PL. 5, FIG. 76. SYN. TAB. III

Antero-posterior diameter of bone, 7 mm.; lateral, 6 mm.

Antero-posterior diameter of medullary canal, 5 mm.; lateral, 4.5 mm.

Medullary index, 114%.

Structure.—With the exception of two rather crude Haversian systems in the posterior ridge the section is composed of lamellæ with oval lacunæ and bushy canaliculi, separated by canals of a branching character into crude laminæ. The general direction of the canals is concentric. The bone shows very little differentiation of structure.

Type I-II.

RIGHT FEMUR OF TYMPANUCHUS AMERICANUS. PRAIRIE CHICKEN. CR. MED. COLL.

PL. 5, FIG. 77. SYN. TAB. III

Antero-posterior diameter of bone, 5 mm.; lateral 6 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 4.5 mm.

The medullary canal is empty. Medullary index, 148%.

Structure.—The bone is composed of lamellæ, crossed at all angles by short canals, some of which extend inward from the external surface. In the posterior and outer wall they unite and form a coarse network, while in the anterior and inner wall they do not. Their lacunæ are oval or narrow and their canaliculi are bushy or long and branching.

A very few Haversian systems of the (Ic) stage are found interrupting the lamellæ of the anterior and inner wall. In the posterior wall are two ridges separated by a concave intermediate wall of bone. Two or three undeveloped Haversian systems are found in each ridge.

The internal circumferential lamellæ surround the medullary canal. They are well developed. Their lacunæ are long and narrow and their canaliculi are long and branching.

Type I.

RIGHT FEMUR OF NUMIDA MELEAGRIS. GUINEA FOWL. CR. MED. COLL.

PL. 5, FIG. 77½. SYN. TAB. III

Antero-posterior diameter of bone, 7 mm.; lateral, 8 mm.

Antero-posterior diameter of medullary canal, 5 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 116%.

Structure.—The section is composed of crude laminæ with oval lacunæ and bushy canaliculi, interrupted by Haversian systems of the (Ic) differentiation. In the anterior and posterior wall the laminæ have a radial direction. The internal circumferential lamellæ with long lacunæ and straight canaliculi form a narrow ring around the medullary canal.

Type II-III, Ic.

RIGHT FEMUR OF CYANOCITTA CRISTATA. BLUE JAY. CR. MED. COLL.

PL. 5, FIG. 78. SYN. TAB. III

Antero-posterior diameter of bone, 2.5 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1.5 mm.

The bone is nearly round. The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of bone substance separated into crude laminæ by short, branching, more or less concentric canals. A few Haversian systems of the (Ic) stage of differentiation appear here and there. The lacunæ are oval and the canaliculi are short and bushy.

Type II-III, Ic.

LEFT FEMUR OF PTEROGLOSSUS TORQUATUS. BANDED TOUCAN. NO. 2854, AMER. MUS. NAT. HIST.

PL. 5, FIG. 79. SYN. TAB. III

Antero-posterior diameter of bone, 3 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 2 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 80%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi, crossed by a few short canals surrounding the medullary canal.

Type I.

LEFT FEMUR OF CHARADRIUS PLUVIALIS. GOLDEN PLOVER. NO. 3356, AMER. MUS. NAT. HIST.

PL. 5, FIG. 80. SYN. TAB. III

Antero-posterior diameter of bone, 2.5 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi, interrupted by a few crude Haversian systems. The lamellæ are partially separated into laminæ by short concentric canals. The bone shows little differentiation.

Type II.

LEFT FEMUR OF AMAZONA ORATRIX. MEXICAN YELLOW-HEADED PARROT. NO. 3025, AMER. MUS. NAT. HIST.

PL. 5. FIG. 81. SYN. TAB. III

Antero-posterior diameter of bone, 4 mm.; lateral, 3.5 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 3 mm.

The medullary canal is full. Medullary index, 177%.

Structure.—The section is composed of lamellæ with oval lacunæ and bushy canaliculi, incompletely separated into dim laminæ by short, concentric canals and interrupted by Haversian canals of the (Ia) differentiation. In the central portion of the section, and extending nearly around it, is a concentric row of Haversian systems of the (Ic) differentiation. In the posterior wall oval lacunæ are crowded together along the medullary surface.

Type II-III, Ia, Ic.

RIGHT FEMUR OF TURDUS MIGRATORIUS. ROBIN. CR. MED. COLL.

PL. 5. FIG. 82. SYN. TAB. III

Antero-posterior diameter of bone, 2 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 129%.

Structure.—The section is composed of concentric lamellæ with oval and long lacunæ and straight and bushy canaliculi surrounding the medullary canal. A concentric row of small Haversian systems of the (Ic) stage is found in the central portion of the wall of the bone. A few canals cross the bone in different directions.

Type I-III, Ic.

FEMUR OF PELECANUS ERYTHRORHYNCHUS. WHITE PELICAN. CR. MED. COLL.

PL. 5, FIG. 83. SYN. TAB. III

Antero-posterior diameter of bone, 12 mm.; lateral, 10 mm.

Antero-posterior diameter of medullary canal, 0; lateral, 0.

The central portion of the bone is cancellous. Medullary index, 0.

Structure.—The external circumferential lamellæ form a narrow enclosing ring. Underneath this is a central ring of Haversian systems of the (Ic) differentiation with canals running at all angles. Beneath this is a narrow ring of internal circumferential lamellæ from the inside of which is derived a cancellous structure occupying the whole medullary region of the bone. The meshes are filled with insoluble matter. A very small medullary canal is situated in the posterior half of the section.

Type I-III, Ic.

RIGHT FEMUR OF ARA MACAO. MACAW. CR. MED. COLL.

PL. 5, FIG. 84. SYN. TAB. III

Antero-posterior diameter of bone, 5.5 mm.; lateral, 4.5 mm.

Antero-posterior diameter of medullary canal, 4.5 mm.; lateral, 3.5 mm.

The medullary canal is full. Medullary index, 178%.

Structure.—The bone is composed of rather crude laminæ, separated and crossed at various angles by numerous canals and interrupted here and there by a few Haversian systems of the (Ic) differentiation. In the posterior ridge the systems form a considerable portion of the thickness of the wall. The laminæ are composed of a few lamellæ with oval and round lacunæ and short, bushy canaliculi.

Type II-III, Ic.

RIGHT FEMUR OF NYCTHERODIUS VIOLACEUS. NIGHT HERON. CR. MED. COLL.

PL. 5, FIG. 85. SYN. TAB. III

Antero-posterior diameter of bone, 5 mm.; lateral, 6 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 4.5 mm.

The medullary canal is full. Medullary index, 148%.

Structure.—The external circumferential lamellæ are not distinct. The bone is composed, for the most part, of short, irregular, and incomplete laminæ, marked off by short, concentric canals. The laminæ are interrupted by small Haversian systems of the (Ic) differentiation which form nearly the whole of the posterior ridge. Each lamina consists of a few lamellæ with oval lacunæ and bushy canaliculi. The canals separating the laminæ are wide and short, and not often uniting. Internal circumferential lamellæ with long lacunæ and straight canaliculi surround the medullary canal.

Type II-III, Ic.

FEMUR OF PAVO CRISTATUS. PEAFOWL. CR. MED. COLL.

PL. 5, FIG. 86. SYN. TAB. III

Antero-posterior diameter of bone, 10 mm.; lateral, 11 mm.

Antero-posterior diameter of medullary canal, 8 mm.; lateral, 10 mm.

The walls of the bone are thin. The medullary canal is large, empty, and has a network of trabeculæ which extends from one wall in a downward direction to the opposite wall.

Medullary index, 277%.

Structure.—The section is composed of a concentric network of canals enclosing short laminæ. The canals intersect at all angles. The laminæ, composed of bone substance with oval lacunæ and relatively few rather short, bushy canaliculi, are interrupted by a few Haversian systems of the (Ic) differentiation.

Type II-III, Ic.

FEMUR OF HALIÆTUS LEUCOCEPHALUS. EAGLE. CR. MED. COLL.

PL. 5, FIG. 87. SYN. TAB. III

Antero-posterior diameter of the bone, 13 mm.; lateral, 14 mm.

Antero-posterior diameter of the medullary canal, 11 mm.; lateral, 11.5 mm.

The medullary canal is empty. Medullary index, 227%.

Structure.—External circumferential lamellæ surround the bone, excepting the posterior ridge where they are interrupted by tendon attachments. Their lacunæ are long, narrow, and concentrically arranged and their canaliculi are rather short and branching.

The central ring of bone is composed of concentric laminæ, interrupted by Haversian systems of the (Ic) differentiation. The canals which separate the laminæ are relatively wide and, on account of their frequent communications with neighboring canals, they present the appearance of a coarse network.

Internal circumferential lamellæ surround the medullary canal. They are fairly well developed and are frequently crossed by canals extending inward from the medullary canal. Their lacunæ are long and narrow and their canaliculi are long and branching.

On the posterior surface are two ridges, one central and one on the posterior inner lateral border. The bone at these points consist of Haversian systems of the (Ic) stage, separated by frequent wide canals which pass to an apex at the outer surface of the ridges. The external circumferential laminæ are absent at these points and tendon insertions, interspersed with many canals, occupy the posterior ridges.

Type II-III, Ic.

LEFT FEMUR OF ARAMUS VOCIFERUS. COURLAN. NO. 2859, AMER. MUS. NAT. HIST.

PL. 5, FIG. 88. SYN. TAB. III

Antero-posterior diameter of bone, 6.5 mm.; lateral, 6 mm.

Antero-posterior diameter of medullary canal, 5.5 mm.; lateral, 5 mm.

The medullary canal is empty. Medullary index, 239%.

Structure.—The section is composed of concentric laminæ with oval lacunæ and bushy canaliculi. In the anterior and posterior walls a single Haversian system of the (Ic) stage is seen. Around the medullary canal is a narrow ring of lamellæ with long lacunæ and straight canaliculi. The bone shows very little variation of structure.

Type II.

LEFT FEMUR OF CENTROCERCUS UROPHASIANUS. SAGE GROUSE OR SAGE HEN. CR. MED. COLL.

PL. 5, FIG. 89. SYN. TAB. III

Antero-posterior diameter of bone, 7 mm.; lateral, 6 mm.

Antero-posterior diameter of medullary canal, 6 mm.; lateral, 5 mm.

The medullary canal is empty. Medullary index, 252%.

Structure.—The bone is composed of short, concentric laminæ, with the exception of a short, narrow crescent of poorly developed Haversian systems in the posterior inner wall. The laminæ are frequently crossed by canals. Each lamina is composed of a few lamellæ with long, narrow lacunæ and long canaliculi. In the posterior wall on both sides of the mid-line are two tendon insertions which mark the attachment of muscles.

Type II.

FEMORA OF MELEAGRIS GALLIPAVO. WILD AND DOMESTIC TURKEYS. CR. MED. COLL.

PL. 6, FIGS. 90, 91, 91½. SYN. TAB. III

Left Wild Turkey	Antero-posterior diameter of bone, 15 mm.; lateral, 17.5 mm. Antero-posterior diameter of medullary canal, 10.5 mm.; lateral, 13 mm. Medullary, index, 109%.
Left Domestic Turkey, 18 lbs. weight	Antero-posterior diameter of bone, 9 mm.; lateral, 11 mm. Antero-posterior diameter of medullary canal, 7 mm.; lateral, 8 mm. Medullary index, 129%.
Left Domestic Turkey, 32 lbs. weight	Antero-posterior diameter of bone, 15 mm.; lateral, 17 mm. Antero-posterior diameter of medullary canal, 13 mm.; lateral, 13 mm. Medullary, index, 194%.

Since the three bones resemble each other closely, one description will answer for all. The medullary canals are full and relatively large. The walls of the bone are thin. The index is higher in the domestic than in the wild turkey.

Structure.—External circumferential lamellæ, with long, narrow lacunæ and many bushy canaliculi, surround the sections. Along the posterior ridges of the femora are small areas of Haversian systems of the (Ic) differentiation which occupy nearly the entire thickness of the posterior walls of the bones. In the anterior walls are small areas of similar Haversian systems. The Haversian canals are large, the lacunæ are oval, and their canaliculi are numerous and bushy.

The lateral walls of the bones are composed of rather crude concentric laminæ, interrupted by a few Haversian systems of the (Ia, Ic) differentiations, separated by prominent concentric canals and crossed at frequent intervals by smaller canals extending from both surfaces of the bone. The laminæ are composed of lamellæ, between which are oval lacunæ with short, bushy canaliculi. Around the medullary canal the internal circumferential lamellæ are not distinct from the adjoining laminæ.

As the femur of the domestic turkey was the first bone to suggest variation in bone type, a number of turkey femora were examined. It was found that they were all second type with Haversian systems of the (Ia) and (Ic) stages of development. The turkeys of greatest weight had the most Haversian systems. A turkey of 32 pounds weight (pl. 6, fig. 91½) had more systems than one of 14, 16, or 18 pounds, and the systems were distributed over a greater area in the different walls of the bone.

Type II-III, Ia, Ic.

LEFT FEMUR OF DENDRAGAPUS OBSCURUS. GROUSE. CR. MED. COLL.

PL. 6, FIG. 92. SYN. TAB. III

Antero-posterior diameter of bone, 5 mm.; lateral, 5.5 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 5 mm.

The medullary canal is empty. Medullary index, 277%.

Structure.—The bone, with the exception of a narrow ring of internal circumferential lamellæ, is composed of short, concentric laminæ, separated by wide canals. Each lamina is composed of lamellæ, with long, narrow or oval lacunæ and long, branching or bushy canaliculi. The canals freely communicate with each other across the laminæ. In the anterior wall (middle portion) is a slight prominence or ridge, consisting of poorly developed Haversian systems, situated close to the external surface. In the posterior wall are two ridges separated by a concave intermediate wall of bone. A single, poorly developed Haversian system is found at the apex of each ridge, around which are collections of oval lacunæ, with short, bushy canaliculi. Close to the internal circumferential lamellæ are a few Haversian systems of a crude type.

Internal circumferential lamellæ surround the medullary canal. Their lacunæ are long and narrow.

Type II.

LEFT FEMUR OF RHEA AMERICANA. RHEA. NO. 2875, AMER. MUS. NAT. HIST.

PL. 6, FIG. 93. SYN. TAB. III

Antero-posterior diameter of bone, 25.5 mm.; lateral, 20.5 mm.

Antero-posterior diameter of medullary canal, 19 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 120%.

Structure.—The section is composed of concentric laminæ, separated and crossed by numerous canals, and, here and there, interrupted by small Haversian systems of the (Ic) differentiation.

Type II-III, Ic.

LEFT FEMUR OF STRUTHIO. OSTRICH. AMER. MUS. NAT. HIST.

PL. 6, FIG. 94. SYN. TAB. III

Antero-posterior diameter of bone, 54 mm.; lateral, 40 mm.

Antero-posterior diameter of medullary canal, 47 mm.; lateral, 32 mm.

The medullary canal is empty. Medullary index, 240%.

Structure.—The bone is large, thin-walled, and light. The section is composed of incomplete, concentric, short and long laminæ, crossed by numerous canals, and interrupted by many Haversian systems of the (Ic) stage of differentiation. The posterior ridges are composed mostly of similar Haversian systems. The central zones of these systems are composed of lamellæ with round lacunæ and short, bushy canaliculi, while their external zones, much narrower, consist of lamellæ with long, narrow lacunæ and straight canaliculi.

Type II-III, Ic.

HAVERSIAN SYSTEM OF THE OSTRICH

PL. 6, FIG. 95. SYN. TAB. III

An Haversian system from the posterior wall of the femur of an ostrich (fig. 94) is enlarged in order to show developmental stages.

The system consists of a central and peripheral portion. The central portion is composed of bone substance with round lacunæ and branching canaliculi forming a delicate canalicular network around the Haversian canal. The peripheral portion is composed of long, narrow lacunæ with straight canaliculi situated in and between lamellæ and arranged concentrically around the central portion. The central portion suggests an early development by its round lacunæ and close proximity to the circulation of the Haversian canal, while the peripheral portion suggests a later and more complete development by its long, narrow lacunæ and removal from the Haversian canal.

LEFT FEMUR OF PHASIANUS TORQUATUS. CHINESE PHEASANT. CR. MED. COLL.

PL. 6, FIG. 95½. SYN. TAB. III

Antero-posterior diameter of bone, 6 mm.; lateral, 6 mm.

Antero-posterior diameter of medullary canal, 4.5 mm.; lateral, 4.5 mm.

The medullary canal is empty. Medullary index, 129%.

Structure.—The section is composed of crude, short laminæ interrupted by a few Haversian systems of the (Ic) differentiation. The lacunæ are oval and the canaliculi are short and bushy. Internal circumferential lamellæ partly surround the medullary canal.

Type II, Ic.

RIGHT FEMUR OF DROMÆUS NOVÆ HOLLANDIÆ. EMU. NO. 2916, AMER. MUS. NAT. HIST.

PL. 6, FIG. 96. SYN. TAB. III

Antero-posterior diameter of bone, 30 mm.; lateral, 26 mm.

Antero-posterior diameter of medullary canal, 22 mm.; lateral, 19.5 mm.

Medullary index, 122%.

Structure.—The section is composed, for the most part, of a background of short laminæ separated by short concentric canals in which are scattering Haversian systems of the (Ic) differentiation. In the outer wall a threefold division is present—external circumferential laminæ, central ring, and internal circumferential lamellæ.

The central ring is composed of Haversian systems, many of which are arranged in a peculiar manner. They occur in groups of two to eight, enclosed within an envelope of laminæ resembling cross-sections of cables. The systems are of the (Ic) differentiation. This is the only bone in which this arrangement has been seen.

Type II-III, Ic.

FEMUR OF ANAS BOSCAS. MALLARD DUCK. CR. MED. COLL.

PL. 6, FIG. 97. SYN. TAB. III

Antero-posterior diameter of bone, 4.5 mm.; lateral, 6.5 mm.

Antero-posterior diameter of medullary canal, 3.5 mm.; lateral, 5 mm.

The medullary canal is empty. Medullary index, 141%.

Structure.—The section is composed of crude laminæ arranged concentrically and interrupted by rather small and poorly developed Haversian systems. The two posterior ridges have groups of the (Ic) differentiation.

Type II-III, Ic.

FEMUR OF EMBERIZA CITRINELLA. YELLOW-HAMMER. CR. MED. COLL.

PL. 6, FIG. 98. SYN. TAB. III

Antero-posterior diameter of bone, 2.5 mm.; lateral, 3 mm.

Antero-posterior and lateral diameters of medullary canals, 0.

The medullary canal is full and situated close to the posterior wall. Medullary index, 0.

Structure.—The section is surrounded by external circumferential lamellæ, within which are a few Haversian systems of the (Ic) differentiation. Large canals extend transversely across the walls of the bone, communicating with the meshes of the central bone structure.

The central portion of the bone, usually occupied by the medullary canal, is composed of a fine cancellous bone with the exception of a small medullary canal, about the size of a fine sewing needle, situated near the posterior wall. The femur is therefore nearly solid bone. The cancellous center is composed of fine lamellæ forming a meshwork extended from the internal circumferential lamellæ. The meshes are filled with granular material, insoluble in ether or chloroform. The lacunæ are small, round, or oval and their canaliculi are short, bushy, and infrequent. Although the bird is a good flier its femur is practically a solid bone.

Type I-III, Ic.

RIGHT FEMUR OF CHAUNA CRISTATA. CRESTED SCREAMER. NO. 2861, AMER. MUS. NAT. HIST.

PL. 6, FIG. 99. SYN. TAB. III

Antero-posterior diameter of bone, 12.5 mm.; lateral, 12 mm.

Antero-posterior diameter of medullary canal, 10.5 mm.; lateral, 10.5 mm.

The medullary canal is empty. Medullary index, 277%.

Structure.—The section has the three divisions well marked. The external circumferential lamellæ form a narrow, distinct ring around the section. Their lacunæ are long and the canaliculi are straight. The central ring is composed of Haversian systems of the (Ic) stage and of canals and fragments of lamellæ. The internal circumferential lamellæ form a distinct ring around the medullary canal. Their lacunæ are long.

Type III, Ic.

LEFT FEMUR OF PANDION CAROLINENSIS. AMERICAN OSPREY. NO. 55, CR. MED. COLL.

PL. 6, FIG. 100. SYN. TAB. III

Antero-posterior diameter of bone, 7.5 mm.; lateral, 8 mm.

Antero-posterior diameter of medullary canal, 6 mm.; lateral, 6.5 mm.

The medullary canal is full. Medullary index, 188%.

Structure.—The external circumferential lamellæ are not distinct from the underlying structure. The bone is composed of crude laminæ which are frequently interrupted by Haversian systems of the (Ic) differentiation, and crossed at differing angles by vascular canals. In the posterior wall near the mid-line is a cluster of small Haversian systems with which tendon intersections are blended. The lacunæ of the laminæ are round and oval.

Concentric laminæ surround the medullary canal. They are frequently crossed by short canals from the medullary canal.

Type II-III, Ic.

RIGHT FEMUR OF SARCORHAMPHUS GRYPHUS. ANDEAN CONDOR. NO. 1276, AMER. MUS. NAT. HIST.

PL. 7, FIG. 101. SYN. TAB. III

Antero-posterior diameter of bone, 18.5 mm.; lateral, 17.5 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 14.5 mm.

The medullary canal is full. Medullary index, 204%.

Structure.—The bone has three divisions. The external circumferential lamellæ form a narrow enclosing ring. Their lacunæ are long and their canaliculi are straight. The central ring is composed of round and elongated Haversian systems of the (Ic) differentiation. Internal circumferential lamellæ form an uneven ring around the medullary canal. Their lacunæ are long.

Type I-III, Ic.

RIGHT FEMUR OF OLOR SP. SWAN. NO. 1681, AMER. MUS. NAT. HIST.

PL. 7, FIG. 102. SYN. TAB. III

Antero-posterior diameter of bone, 11.5 mm.; lateral, 10.5 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 8 mm.

Medullary index, 87%.

Structure.—The bone has the three divisions. The external circumferential lamellæ form a narrow enclosing ring. Their lacunæ are long and their canaliculi are straight. The central ring is composed of crude laminæ with oval lacunæ, partly displaced by Haversian systems of the (Ic) differentiation. In the anterior inner wall indistinct laminæ appear. A wide ring of lamellæ, partly separated into laminæ, surrounds the medullary canal. The lamellæ have long lacunæ and are crossed by numerous canals.

Type II-III, Ic.

LEFT FEMUR OF GAVIA STELLATA. RED-THROATED LOON. NO. 2801, AMER. MUS. NAT. HIST.

PL. 7, FIG. 103. SYN. TAB. III

Antero-posterior diameter of bone, 8.5 mm.; lateral, 6.5 mm.

Antero-posterior diameter of medullary canal, 5 mm.; lateral, 4 mm.

The medullary canal is divided into two equal parts, antero-posteriorly by a partition of bone. Medullary index, 184%.

Structure.—The section has the three divisions. The external circumferential lamellæ form a narrow enclosing ring. The lacunæ are long and oval and their canaliculi are long and bushy. The central ring is composed of lamellæ and Haversian systems of the (Ic) differentiation. The internal circumferential lamellæ with long lacunæ and straight canaliculi surround the medullary canal and form the dividing partition. Four large vascular canals appear in the anterior wall and two or three in the posterior. Their lacunæ are long and oval with long and straight canaliculi.

Type I-III, Ic.

FEMUR OF GALLUS. DOMESTIC CHICKEN. CR. MED. COLL.

PL. 7, FIG. 104. SYN. TAB. III

Antero-posterior diameter of bone, 9 mm.; lateral, 9 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 153%.

Structure.—Well marked external circumferential lamellæ with long, narrow lacunæ and branching canaliculi surround the section. The central ring is composed of irregularly shaped Haversian systems of the (Ic) differentiation. At the posterior ridge they occupy the entire thickness of the wall of the bone as far as the internal circumferential lamellæ. Interspersed between the systems are short lamellæ.

Internal circumferential lamellæ completely surround the medullary canal. Their lacunæ are long and narrow and their canaliculi are bushy.

Type I-III, Ic.

FEMUR OF CORVUS AMERICANUS. CROW. CR. MED. COLL.

PL. 7, FIG. 105. SYN. TAB. III

Antero-posterior diameter of bone, 4 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 2.5 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 70%.

Structure.—External circumferential lamellæ form a wide ring around the bone. The lacunæ are oval with bushy, connecting canaliculi.

The central ring is composed of lamellæ and irregular Haversian systems of the (Ic) stage of development. There is very little difference in the structure of the various parts of the bone.

Internal circumferential lamellæ form a narrow ring around the medullary canal. Their lacunæ are narrow and long and their canaliculi are long and branching.

Type I-III, Ic.

FEMUR OF ASIO WILSONIANUS. LONG-EARED OWL

PL. 7, FIG. 106. SYN. TAB. III

Antero-posterior diameter of bone, 8 mm.; lateral, 7 mm.

Antero-posterior diameter of medullary canal, 6 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 178%.

Structure.—The external circumferential lamellæ surround the section. Their lacunæ are long, numerous, and have very fine, long canaliculi. Here and there canals traverse the entire thickness of them all.

The central ring is composed of irregularly shaped Haversian system of the (Ic) stage of development, extending between which are numerous short canals. The lacunæ are oval, numerous, and have bushy canaliculi.

The internal circumferential lamellæ form a thick, heavy ring around the medullary canal. In the outer wall of the bone they tend to separate into laminæ. The whole ring of internal circumferential lamellæ forms about one-third of the thickness of the wall of the bone. It is traversed by many canals extending from the medullary canal into the canals of the Haversian systems. Their lacunæ are long and numerous and their canaliculi are bushy.

Type I-II-III, Ic.

RIGHT FEMUR OF BERNICLA CANADENSIS. WILD GOOSE

PL. 7. FIG. 107. SYN. TAB. III

Antero-posterior diameter of bone, 9 mm.; lateral, 8.5 mm.

Antero-posterior diameter of medullary canal. 7 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 178%.

Structure.—The external circumferential lamellæ surround the section. Their lacunæ are long and narrow and their canaliculi are rather few in number. At the posterior ridge are found many Haversian systems of the (Ic) differentiation. The anterior wall of the bone is composed of similar Haversian systems occupying the whole thickness of the wall between the external and internal circumferential lamellæ. The remainder of the bone shows quite different structures and arrangements in the different portions of the wall. Laminæ occupy the inner half of the wall, while Haversian systems of the (Ic) stage of development occupy the outer half and are situated under the external circumferential lamellæ.

The two halves are well marked and distinct from each other. The lacunæ of the systems and laminæ are oval and their canaliculi are few and short. The canals between the laminæ are irregular and branching. The internal circumferential lamellæ are well developed. In the inner wall of the bone quite large canals extend from the medullary canal through the laminæ to the Haversian canals between the laminæ.

Type II-III, Ic.

LEFT FEMUR OF LEPTOPTILOS SP. STORK. NO. 2827, AMER. MUS. NAT. HIST.

PL. 7, FIG. 108. SYN. TAB. III

Antero-posterior diameter of bone, 17 mm.; lateral, 15 mm.

Antero-posterior diameter of medullary canal, 14.5 mm.; lateral, 13.5 mm.

The medullary canal is empty. Medullary index, 327%.

Structure.—The section has the three divisions; the external circumferential lamellæ form a narrow ring around the section and have long lacunæ and straight canaliculi. The central ring is composed of Haversian systems of the (Ic) differentiation between which are canals and short fragments of lamellæ with oval lacunæ and bushy canaliculi. The internal circumferential lamellæ form a distinct, narrow ring around the medullary canal. Their lacunæ are long and canaliculi are straight.

Type I-III, Ic.

RIGHT FEMUR OF ANTHRACOCEROS MALABARICUS. HORN BILL. NO. 2887, AMER. MUS. NAT. HIST.

Pl. 7, Fig. 109. Syn. Tab. III

Antero-posterior diameter of bone, 6.5 mm.; lateral, 6 mm.

Antero-posterior diameter of medullary canal, 5.5 mm.; lateral, 5 mm.

The medullary canal is empty. Medullary index, 240%.

Structure.—The section has three divisions. The external circumferential lamellæ with long lacunæ and straight canaliculi form a distinct, narrow ring around the bone. The central ring is composed of lamellæ with round and oval lacunæ, interrupted by many canals and Haversian systems of the (Ic) stage. The internal circumferential lamellæ with long lacunæ form a narrow distinct ring around the medullary canal.

Type I-III, Ic.

FEMUR OF ASTUR ATRICAPILLUS. GOSHAWK. CR. MED. COLL.

Pl. 7, Fig. 110. Syn. Tab. III

Antero-posterior diameter of bone, 4 mm.; lateral, 4.3 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 3.3 mm.

The medullary canal is empty. Medullary index, 139%.

Structure.—The section is surrounded by external circumferential lamellæ, fairly well developed. Their lacunæ are more frequently oval than long. The canaliculi are bushy.

In the inner lateral posterior wall is a slight ridge to which are attached muscle tendons penetrating the external lamellæ. Underneath the external circumferential lamellæ is a thick ring of Haversian systems of the (Ic) stage of development. The ring is crossed at all angles by wide, irregular canals.

The medullary canal is enclosed by internal circumferential lamellæ with long lacunæ and canaliculi.

Type I-III, Ic.

LEFT FEMUR OF INOCOTIS PAPILLOSUS. IBIS. NO. 3178, AMER. MUS. NAT. HIST.

PL. 7, FIG. 111. SYN. TAB. III

Antero-posterior diameter of bone, 7 mm.; lateral, 6.5 mm.

Antero-posterior diameter of medullary canal, 6 mm.; lateral, 5.5 mm.

Medullary index, 264%.

Structure.—The section shows the three divisions. External circumferential lamellæ form a narrow ring around the section. Their lacunæ are long and narrow. Underneath this ring is a wide central ring of lamellæ, Haversian systems, and canals. The lamellæ have oval lacunæ and bushy canaliculi. The Haversian systems are of the (Ic) stage of development. Around the medullary canal is a ring of lamellæ with long and narrow lacunæ.

Type I-III, Ic.

RIGHT FEMUR OF CATHARTES AURA. TURKEY-BUZZARD. NO. 70, CR. MED. COLL.

PL. 7, FIG. 112. SYN. TAB. III

Antero-posterior diameter of bone, 9.5 mm.; lateral, 8 mm.

Antero-posterior diameter of medullary canal, 7.5 mm.; lateral, 7 mm.

The medullary canal is empty. Medullary index, 219%.

Structure.—The walls are very thin and hard. The usual three structural divisions are present. The external circumferential lamellæ form a narrow ring around the section excepting in the posterior ridge where a few tendon insertions displace them. Their lacunæ are long, narrow, and well developed. The central ring is composed of Haversian systems of the (Ic) differentiation. The lacunæ are some distance apart and their canaliculi are rather infrequent. The ring is crossed at all angles by canals. The internal circumferential lamellæ constitute a narrow ring around the medullary canal. Their lacunæ are well developed.

Type I-III, Ic.

IX. MAMMALS—BATS

Fifty-five femora were examined.

GENERAL CHARACTER OF THE FEMUR

The prevailing shape of the femur is elliptical. Several are round, and a few are plano-convex. The medullary canals are all full of marrow and one, *Desmodus rotundus,* is full of red marrow. No cancellous bone and no trabeculæ are found. The medullary surfaces are smooth or very slightly corrugated.

The medullary index varies from 12% to 178% with an average of 48.6%.

The type of structure is first. The bone substance is lamellated, the lacunæ are round, oval or long, and the canaliculi are bushy, short, or long. In some of the large bats of the Pteropus genus, Haversian canals of the (Ia) differentiation are present.

Detailed Examination

RIGHT FEMUR OF MORMOOPS. NO. 102231, U. S. NAT. MUS.

Pl. 8, Fig. 113. Syn. Tab. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.6 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 59%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF RHINOLOPHUS MEHELYI. NO. 84768, U. S. NAT. MUS.

Pl. 8, Fig. 114. Syn. Tab. IV

Antero-posterior diameter of bone, 0.8 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 64%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF STURNIRA LILIUM. NO. 115053, U. S. NAT. MUS.

Pl. 8, Fig. 115. Syn. Tab. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.9 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 29%.

Structure.—The section is composed of concentric lamellæ with long, narrow lacunæ and long, straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF LONCHORHINA. NO. 173849, U. S. NAT. MUS.

Pl. 8, Fig. 116. Syn. Tab. IV

Antero-posterior diameter of bone, 0.9 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 55%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF ROUSETTUS AMPLEXICAUDATUS. NO. 175844, U. S. NAT. MUS.

PL. 8, FIG. 117. SYN. TAB. IV

Antero-posterior diameter of bone, 2.5 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 44%.

Structure.—The section is dimly separated into three concentric divisions, external, central, and internal. The external and central divisions have lamellæ with long, narrow lacunæ and straight canaliculi, while the internal division has lamellæ with oval lacunæ and bushy canaliculi. The bone shows the threefold division.

Type I.

RIGHT FEMUR OF HIPPOSIDEROS LARVATUS. NO. 152076, U. S. NAT. MUS.

PL. 8, FIG. 118. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi separated into external, central, and internal rings which surround the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF HEMIDERMA. NO. 123744, U. S. NAT. MUS.

PL. 8, FIG. 119. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF DESMODUS ROTUNDUS. NO. 114977, U. S. NAT. MUS.

PL. 8, FIG. 120. SYN. TAB. IV

Antero-posterior diameter of bone, 1.5 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 2 mm.

The medullary canal is full of red marrow. Medullary index, 129%.

Structure.—The section is flattened antero-posteriorly and is surrounded by external circumferential lamellæ. The central ring is widest and is composed of oval lacunæ with very delicate bushy canaliculi. The posterior wall has two ridges. In the outer ridge is a vascular canal. The bone shows the threefold division.

Type I.

LEFT FEMUR OF LEPTONYCTERIS. NO. 105129, U. S. NAT. MUS.

PL. 8, FIG. 121. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ divided into wide external and narrow internal rings. The external is composed of lamellæ with oval lacunæ and bushy canaliculi, and the internal, of lamellæ with long, narrow lacunæ and straight canaliculi. The bone has the twofold division.

Type I.

RIGHT FEMUR OF RHINOPOMA. (PALESTINE.) NO. 122140, U. S. NAT. MUS.

PL. 8, FIG. 122. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.9 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 29%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF EROPHYLLA BOMBIFRONS. NO. 86262, U. S. NAT. MUS.

PL. 8, FIG. 123. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF PHYLLOSTOMA HASTATUM. NO. 102906, U. S. NAT. MUS.

PL. 8, FIG. 124. SYN. TAB. IV

Antero-posterior diameter of bone, 2.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 64%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The lamellæ are dimly separated into wide external and narrow internal rings by a condensation of the lacunæ around the medullary canal. Twofold division.

Type I.

LEFT FEMUR OF EPOMOPHORUS WAHLBERGII. NO. 113451, U. S. NAT. MUS.

PL. 8, FIG. 125. SYN. TAB. IV

Antero-posterior diameter of bone, 2 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of lamellæ divided into three concentric rings. The external is narrow and composed of lamellæ with long lacunæ and straight canaliculi; the central is wide and consists of lamellæ with oval lacunæ and bushy canaliculi; and the internal is narrow and composed of lamellæ with long lacunæ and straight canaliculi. The bone shows the threefold division.

Type I.

LEFT FEMUR OF GLOSSOPHAGA ELONGATA. NO. 102107, U. S. NAT. MUS.

PL. 8, FIG. 126. SYN. TAB. IV

Antero-posterior diameter of bone, 0.9 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.4 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 28%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF NYCTALUS AVIATOR. NO. 102098, U. S. NAT. MUS.

PL. 8, FIG. 127. SYN. TAB. IV

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 12%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF SCOTOPHILUS HEATHII. NO. 13692, U. S. NAT. MUS.

PL. 8, FIG. 128. SYN. TAB. IV

Antero-posterior diameter of bone, 2 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 1.2 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 65%.

Structure.—The section is divided into two rings, an external composed of lamellæ with oval lacunæ and bushy canaliculi, and an internal composed of lamellæ with long lacunæ and straight canaliculi. Twofold division.

Type I.

RIGHT FEMUR OF MINIOPTERUS SCHREIBERSII. NO. 152610, U. S. NAT. MUS.

PL. 8, FIG. 129. SYN. TAB. IV

Antero-posterior diameter of bone, 0.8 mm.; lateral, 0.7 mm.

Antero-posterior diameter of medullary canal, 0.3 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 64%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF PROMOPS FOSTERI. NO. 105676, U. S. NAT. MUS.

PL. 8, FIG. 130. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF VESPERTILIO MURINUS. NO. 5333, U. S. NAT. MUS.

PL. 8, FIG. 131. SYN. TAB. IV

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 12%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF MOLOSSUS NIGRICANS. NO. 8268, U. S. NAT. MUS.

PL. 8, FIG. 132. SYN. TAB. IV

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.7 mm.; lateral, 0.8 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of concentric lamellæ with long lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF DASYPTERUS INTERMEDIUS. NO. 22408, U. S. NAT. MUS.

PL. 8, FIG. 133. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.9 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 29%.

Structure.—The section is composed of lamellæ divided into wide external and narrow internal rings. The external consists of lamellæ with oval lacunæ and straight canaliculi, and the internal, of lamellæ with long lacunæ and straight canaliculi. The bone has the twofold division.

Type I.

LEFT FEMUR OF MOLOSSUS MAJOR. NO. 101893, U. S. NAT. MUS.

PL. 8, FIG. 134. SYN. TAB. IV

Antero-posterior diameter of bone, 0.6 mm.; lateral, 0.6 mm.

Antero-posterior diameter of medullary canal, 0.4 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 80%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi. Two divisions appear, external and internal. The external is wide and the internal is narrow. The concentric divisions surround the medullary canal. The bone shows a twofold division.

Type I.

LEFT FEMUR OF ANTROZOUS PALLIDUS. NO. 63386, U. S. NAT. MUS.

PL. 8, FIG. 135. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.8 mm.; lateral, 0.8 mm.

The medullary canal is full. Medullary index, 178%.

Structure.—The section is thin-walled and composed of concentric lamellæ with oval and round lacunæ with bushy canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF EUMOPS CALIFORNICUS. NO. 61387, U. S. NAT. MUS.

PL. 8, FIG. 136. SYN. TAB. IV

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.9 mm.; lateral, 0.9 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi, divided into wide external and narrow internal rings. Twofold division.

Type I.

RIGHT FEMUR OF PLECOTUS AURITUS. NO. 152597, U. S. NAT. MUS.

PL. 8, FIG. 137. SYN. TAB. IV

Antero-posterior diameter of bone, 0.8 mm.; lateral, 0.7 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF NYCTICEIUS HUMERALIS. NO. 115141, U. S. NAT. MUS.

PL. 8, FIG. 138. SYN. TAB. IV

Antero-posterior diameter of bone, 0.8 mm.; lateral, 0.7 mm.

Antero-posterior diameter of medullary canal, 0.6 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 116%.

Structure.—The section is composed of a few concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF MYOTIS MYOTIS. NO. 86500, U. S. NAT. MUS.

PL. 8, FIG. 139. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF EPTESICUS BAHAMENSIS. NO. 121929, U. S. NAT. MUS.

PL. 8, FIG. 140. SYN. TAB. IV

Antero-posterior diameter of bone, 0.8 mm.; lateral, 0.7 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF NYCTERIS BOREALIS. NO. 101945, U. S. NAT. MUS.

PL. 8, FIG. 141. SYN. TAB. IV

Antero-posterior diameter of bone, 0.8 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.4 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF GLISCHROPUS TYLOPUS. NO. 142385, U. S. NAT. MUS.

PL. 8. FIG. 142. SYN. TAB. IV

Antero-posterior diameter of bone, 0.5 mm.; lateral, 0.4 mm.

Antero-posterior diameter of medullary canal, 0.3 mm.; lateral, 0.2 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—The section is composed of lamellæ with round lacunæ and bushy canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF NYCTERIS CINEREA. NO NUMBER, U. S. NAT. MUS.

PL. 8, FIG. 143. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi, divided into wide external and narrow internal rings which surround the medullary canal. The bone shows a twofold division.

Type I.

LEFT FEMUR OF PHYLLONYCTERIS. NO. 103501, U. S. NAT. MUS.

PL. 8, FIG. 144. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF MEGADERMA SPASMA. NO. 114272, U. S. NAT. MUS.

PL. 8, FIG. 145. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi. The lamellæ are divided into wide external and narrow internal rings which partly surround the medullary canal. The internal ring is limited to the lateral walls. The bone shows a partial twofold division.

Type I.

RIGHT FEMUR OF PTERONOTUS. NO. 113570, U. S. NAT. MUS.

PL. 8, FIG. 146. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF BALANTIOPTERYX PLICATA. NO. 142606, U. S. NAT. MUS.

PL. 8, FIG. 147. SYN. TAB. IV

Antero-posterior diameter of bone, 0.5 mm.; lateral, 0.5 mm.

Antero-posterior diameter of medullary canal, 0.3 mm.; lateral, 0.3 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of a few concentric lamellæ with round and oval lacunæ and bushy canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

RIGHT FEMUR OF SACCOPTERYX. NO. 123800, U. S. NAT. MUS.

PL. 8, FIG. 148. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.4 mm.; lateral, 0.3 mm.

The medullary canal is full. Medullary index, 18%.

The bone is flat on the posterior side.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi surrounding the medullary canal. The bone is uniform.

Type I.

LEFT FEMUR OF PETALIA. NO. 154866, U. S. NAT. MUS.

PL. 8, FIG. 149. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.9 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform. Type I.

LEFT FEMUR OF MONOPHYLLUS. NO. 113677, U. S. NAT. MUS.

PL. 8, FIG. 150. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform. Type I.

LEFT FEMUR OF VAMPYROPS LINEATUS. U. S. NAT. MUS.

PL. 8, FIG. 151. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform. Type I.

RIGHT FEMUR OF CHILONYCTERIS. NO. 173842, U. S. NAT. MUS.

PL. 8, FIG. 152. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform. Type I.

RIGHT FEMUR OF CYNOPTERUS. NO. 141241, U. S. NAT. MUS.

PL. 8, FIG. 153. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform. Type I.

LEFT FEMUR OF ARTIBEUS PALMARUM. NO. 102866, U. S. NAT. MUS.

PL. 8, FIG. 154. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform. Type I.

LEFT FEMUR OF BRACHYPHYLLA. NO. 103251, U. S. NAT. MUS.

PL. 8, FIG. 155. SYN. TAB. IV

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform. Type I.

RIGHT FEMUR OF MACROGLOSSUS MINIMUS. NO. 171695, U. S. NAT. MUS.

PL. 8, FIG. 156. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 0.8 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The bone is uniform. Type I.

LEFT FEMUR OF TAPHOZOUS PHILIPPINENSIS. NO. 144851, U. S. NAT. MUS.

PL. 8, FIG. 157. SYN. TAB. IV

Antero-posterior diameter of bone, 1 mm.; lateral, 1 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi surrounding the medullary canal. The lamellæ are dimly separated into external and internal rings. Incomplete twofold division.

Type I.

RIGHT FEMUR OF CHEIROMELES TORQUATUS. NO. 102462, U. S. NAT. MUS.

PL. 8, FIG. 158. SYN. TAB. IV

Antero-posterior diameter of bone, 3.5 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 27%.

Structure.—The section is composed of concentric lamellæ with narrow lacunæ and long, straight canaliculi, divided into two distinct rings—external wide and internal narrow—which surround the medullary canal. The internal ring has very few lacunæ. Twofold division.

Type I.

RIGHT FEMUR OF NOCTILIO. NO. 49545, U. S. NAT. MUS.

PL. 8, FIG. 159. SYN. TAB. IV

Antero-posterior diameter of bone, 2 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 0.9 mm.

The medullary canal is full. Medullary index, 82%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ. In the outer wall there are a few minute canals surrounded by clear areas of bone substance, around which oval lacunæ with bushy canaliculi are assuming a partial concentric arrangement.

Type I-III, Ia.

LEFT FEMUR OF PTEROPUS MOLOSSINUS (SMALL). NO. 151561, U. S. NAT. MUS.

PL. 8, FIG. 160. SYN. TAB. IV

Antero-posterior diameter of bone, 2.5 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—The section is composed of lamellæ with oval lacunæ and straight canaliculi indistinctly separated into three concentric rings. Incomplete threefold division.

Type I.

RIGHT FEMUR OF PTEROPUS MOLOSSINUS (LARGE). U. S. NAT. MUS.

PL. 8, FIG. 161. SYN. TAB. IV

Antero-posterior diameter of bone, 3 mm.; lateral, 3.5 mm.

Antero-posterior diameter of medullary canal, 2.5 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 147%.

Structure.—The section is composed of lamellæ with long, narrow lacunæ and straight canaliculi enclosing the medullary canal. The lamellæ are divided into two rings, a narrow external and wide internal. In the inner wall the lamellæ are interrupted by a few canals of the (Ia) differentiation. The femur shows a little advancement. Twofold division.

Type I-III, Ia.

RIGHT FEMUR OF PTEROPUS ALDABRENSIS. NO. 20989, U. S. NAT. MUS.

PL. 8, FIG. 162. SYN. TAB. IV

Antero-posterior diameter of bone, 2 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 43%.

Structure.—The section is composed of concentric lamellæ with oval and long lacunæ and straight canaliculi interrupted by a few crude, undeveloped Haversian systems of the (Ia) differentiation.

Type I-III, Ia.

RIGHT FEMUR OF PTEROPUS. (CELEBES.) NO. 172460, U. S. NAT. MUS.

PL. 8, FIG. 163. SYN. TAB. IV

Antero-posterior diameter of bone, 4 mm.; lateral, 3.5 mm.

Antero-posterior diameter of medullary canal, 2.5 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 55%.

Structure.—The section is composed of a wide external band of lamellæ divided into two nearly equal concentric rings by longitudinal canals of the (Ia) differentiation. The lacunæ are oval and narrow and the canaliculi are straight. Internal circumferential lamellæ with long lacunæ and straight canaliculi surround the medullary canal.

Type I-III, Ia.

RIGHT FEMUR OF PTEROPUS. (JAVA.) NO. 12616, U. S. NAT. MUS.

PL. 8, FIG. 164. SYN. TAB. IV

Antero-posterior diameter of bone, 3 mm.; lateral, 3.5 mm.

Antero-posterior diameter of medullary canal, 2.5 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 91%.

Structure.—The section is composed of concentric lamellæ with oval and long lacunæ and straight canaliculi, interrupted by many very crude Haversian systems of the (Ia) differentiation.

Type I-III, Ia.

RIGHT FEMUR OF PTEROPUS LEPICOS. NO. 112404, U. S. NAT. MUS.

PL. 8, FIG. 165. SYN. TAB. IV

Antero-posterior diameter of bone, 2.5 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—The section is composed of concentric lamellæ with oval and long lacunæ and straight canaliculi crossed by numerous radiating canals. Here and there a few very crude Haversian systems of the (Ia) differentiation are seen. The bone is uniform.

Type I-III, Ia.

RIGHT FEMUR OF PTEROPUS. (TONGATABU.) NO. 173884, U. S. NAT. MUS.

PL. 8, FIG. 166. SYN. TAB. IV

Antero-posterior diameter of bone, 3 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and straight canaliculi, partially separated by undeveloped Haversian systems of the (Ia) differentiation into two laminæ. The systems occupy a central concentric position. The bone has a twofold division.

Type I-III, Ia.

RIGHT FEMUR OF PTEROPUS POLIOCEPHALUS. U. S. NAT. MUS.

PL. 9, FIG. 167. SYN. TAB. IV

Antero-posterior diameter of bone, 3.5 mm.; lateral, 3.5 mm.

Antero-posterior diameter of medullary canal, 2 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 49%.

Structure.—The section has the three concentric divisions, external, central, and internal. The lacunæ are oval and the canaliculi are straight. In the central division or ring are found numerous Haversian canals situated nearer to the internal than to the external division. The canals run parallel with the medullary canal. They are surrounded by clear areas of bone substance which are crossed radially by very fine canaliculi from adjacent lacunæ. The canals with their canaliculi and lacunæ are crude outlines of Haversian systems of the (Ia) differentiation. The bone has the threefold division.

Type I-III, Ia.

X. OTHER MAMMALS NOT INCLUDING MAN

One hundred and thirty-three femora were examined.

General Character of the Femur

The general shape of the femur varies very considerably. Some bones are triangular, many elliptical, some round, some indeterminate, and a few are plano-convex. The majority of them are elliptical.

The medullary canals, with one or two exceptions, are full of marrow, and a large number have cancellous bone, the meshes of which are filled with marrow. The medullary surfaces are generally rough or irregularly corrugated. The medullary index varies from 9% to 289% with an average of 63.3%.

The type of structure varies greatly. Nearly all types and type combinations in their various stages of differentiation are found. The bone units of monotremes and marsupials present an earlier differentiation than the higher mammals.

The first type bone is present in many genera and may be associated with the undeveloped third type of the (Ia) differentiation. A number of mammalian femora present a well marked second type structure. The laminæ are much better developed than in birds. In most of these bones Haversian systems are found to the greatest extent in the posterior ridges. The pure third type of the (C) differentiation occurs only in a few mammals. Of these the African elephant is the best example. The majority of mammalian femora exhibit type combinations. These may be first and third, second and third, or first, second, and third in some form of differentiation. The majority are composed of the first and third types.

Detailed Examination

LEFT FEMUR OF TUPAIA. TREE-SHREW. AMER. MUS. NAT. HIST.

Pl. 9, Fig. 168. Syn. Tab. V

Antero-posterior diameter of bone, 3 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 2 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 67%.

Structure.—With the exception of a few small and poorly developed Haversian systems of the (Ib) differentiation in the posterior and inner walls, the section is composed of lamellæ with oval lacunæ and straight canaliculi. The specimen shows very little differentiation of structure. The bone is uniform.

Type I.

RIGHT FEMUR OF ECHIDNA. EGG-LAYING MAMMAL. NO. 17355, AMER. MUS. NAT. HIST.

PL. 9, FIG. 169. SYN. TAB. V

Antero-posterior diameter of bone, 6 mm.; lateral, 11.5 mm.

Antero-posterior diameter of medullary canal, 3.5 mm.; lateral, 6.5 mm.

The medullary canal is full. Medullary index, 49%.

Structure.—A few primitive Haversian systems of the (Ib) differentiation are found in the inner and outer walls. The section, for the most part, is composed of basic bone substance with round and oval lacunæ and bushy canaliculi, crossed at various angles by branching canals. Around the medullary canal the lacunæ are longer and the lamellæ denser than elsewhere. In the outer wall of the medullary canal cancellous bone occurs. The bone shows some departure from the first type by its crude Haversian systems.

Type I.

LEFT FEMUR OF ORNITHORHYNCHUS. DUCK BILL. EGG-LAYING MAMMAL. NO. 13354 U. S. NAT. MUS.

PL. 9, FIG. 170. SYN. TAB. V

Antero-posterior diameter of the bone, 4 mm.; lateral, 5 mm.

Antero-posterior diameter of the medullary canal, 2.5 mm.; lateral, 3.5 mm.

The medullary canal is full. Medullary index, 79%.

Structure.—The section is divided about equally into two concentric parts or rings not separated by any well marked boundary. The external half is composed of basic bone substance with a great many oval and round lacunæ and short, bushy canaliculi. In some places, as in the outer and inner ridges, crude Haversian systems appear. Wide canals arranged transversely, obliquely, and concentrically occur at frequent intervals. The internal half consists of lamellæ with long lacunæ and canaliculi, interrupted in the outer wall by Haversian systems of the (Ib) differentiation. The lamellæ are crossed by canals, and in the anterior wall the canals run concentrically.

Type I-III, Ib.

LEFT FEMUR OF CAVIA CUTLERI. GUINEA PIG. AMER. MUS. NAT. HIST.

PL. 9, FIG. 171. SYN. TAB. V

Antero-posterior diameter of bone, 6 mm.; lateral, 4 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 3 mm.

The medullary canal is full. Medullary index, 100%.

Structure.—The three divisions are plainly marked. The external circumferential lamellæ with long lacunæ and straight canaliculi form a narrow ring around the bone. The central ring consists of basic bone substance with round and oval lacunæ and bushy canaliculi, interrupted by poorly developed Haversian systems of the (Ia) differentiation and crossed by radiating canals. In the posterior wall the ring consists of crude Haversian systems between which is bone substance with oval lacunæ and bushy canaliculi.

The internal circumferential lamellæ form a narrow ring around the medullary canal. The bone shows a threefold division.

Type I-III, Ia.

LEFT FEMUR OF SCALOPUS AQUATICUS. MOLE. AMER. MUS. NAT. HIST.

PL. 9, FIG. 172. SYN. TAB. V

Antero-posterior diameter of bone, 1.5 mm.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 80%.

Structure.—The section is composed of lamellæ with long and oval lacunæ and straight canaliculi, partially separated into two equal, concentric rings by concentric, branching canals and crossed at various angles by radiating canals. In the posterior wall the lamellæ are crude Haversian systems of the (Ib) differentiation.

Type I-III, Ib.

RIGHT FEMUR OF SOREX. SHREW. AMER. MUS. NAT. HIST.

PL. 9, FIG. 173. SYN. TAB. V

Antero-posterior diameter of bone, 3 mm.; lateral, 3.3 mm.

Antero-posterior diameter of medullary canal, 1.2 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 22%.

Structure.—The section is composed of bone substance with oval lacunæ and bushy canaliculi, frequently interrupted by primitive Haversian systems of the (Ib) differentiation and crossed by canals. In some places fragments of external circumferential lamellæ appear. In the posterior wall is a group of oval lacunæ with short, bushy canaliculi.

The bone shows but little differentiation of structure. It is uniformly of an early differentiation.

Type I-III, Ib.

RIGHT FEMUR OF MACROPUS. WALLABY. NO. 22810, AMER. MUS. NAT. HIST.

PL. 9, FIG. 174. SYN. TAB. V

Antero-posterior diameter of bone, 14 mm.; lateral, 14 mm.

Antero-posterior diameter of medullary canal, 10 mm.; lateral, 10.5 mm.

The medullary canal is full. Medullary index, 115%.

Structure.—The section is composed of lamellæ with oval long lacunæ and straight canaliculi, interrupted in the posterior wall by vascular canals and crude Haversian systems, and elsewhere by frequent radiating canals and Haversian systems of the (Ia) differentiation. It is indistinctly laminated.

Type I-III, Ia.

LEFT FEMUR OF SOLENODON PARADOXUS (YOUNG). AMER. MUS. NAT. HIST.

PL. 9, FIG. 175. SYN. TAB. V

Antero-posterior diameter of bone, 5 mm.; lateral, 4.5 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 3.5 mm.

The medullary canal is full. Medullary index, 165%.

Structure.—The section is composed of lamellæ with round and oval lacunæ and bushy canaliculi, frequently interrupted by Haversian systems of the (Ia) and (Ib) differentiation and crossed by many oblique and radiating canals which take their origin in the medullary canal. The bone shows a very incomplete differentiation.

Type I-III, Ia, Ib.

RIGHT FEMUR OF SOLENODON PARADOXUS (ADULT). AMER. MUS. NAT. HIST.

PL. 9, FIG. 176. SYN. TAB. V

Antero-posterior diameter of bone, 6.5 mm; lateral, 5 mm.

Antero-posterior diameter of medullary canal, 4.5 mm.; lateral, 3.5 mm.

The medullary canal is full. Medullary index, 94%.

Structure.—The section shows the three divisions. The external circumferential lamellæ form a distinct ring around the section. It is widest in the inner wall. The lacunæ are long and the canaliculi are bushy and straight. The central ring is composed of lamellæ with oval lacunæ and bushy canaliculi, interrupted by crude Haversian systems of the (Ia) and (Ib) differentiations. The section is nearly all lamellæ. The internal circumferential lamellæ form a fragmentary ring around the medullary canal. Their lacunæ are oval and straight and the canaliculi are straight.

Type I-III, Ia, Ib.

FEMUR OF LEMUR MONGOZ. NO. 86849, U. S. NAT. MUS.

PL. 9, FIG. 177. SYN. TAB. V

Antero-posterior diameter of bone, 9 mm.; lateral, 7 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 4.5 mm.

The medullary canal is full. Medullary index, 100%.

Structure.—The section is composed of lamellæ with long lacunæ and straight canaliculi, divided into wide external and narrow internal rings. The lamellæ of the external ring are interrupted by small and rather crude Haversian systems of the (Ib) differentiation and by vascular canals which occupy a concentric position in the wall of the bone. The internal ring of lamellæ with long lacunæ and straight canaliculi surrounds the medullary canal. The bone has the twofold division.

Type I-III, Ib.

LEFT FEMUR OF COLOBUS ABYSSINICUS CAUDATUS. NO. 27711, AMER. MUS. NAT. HIST.

PL. 9, FIG. 178. SYN. TAB. V

Antero-posterior diameter of bone, 12.5 mm.; lateral, 13 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 43%.

Structure.—The section is composed of a very wide band of external circumferential lamellæ, interrupted by numerous very crude Haversian systems of the (Ia) and (Ib) differentiations. The band forms nearly the whole width of the wall of the bone. In the posterior wall the lamellæ are displaced by small undeveloped Haversian systems and in the outer wall a narrow crescent of Haversian systems of the (C) stage appears just external to the internal circumferential lamellæ.

Internal circumferential lamellæ surround the medullary canal. Generally the lacunæ are long and narrow and the canaliculi are straight, but in the posterior wall the lacunæ are oval. The bone shows the twofold division.

Type I-III, Ia, Ib, C.

FEMUR OF PUTORIUS VULGARIS. WEASEL. CR. MED. COLL.

PL. 9, FIG. 179. SYN. TAB. V

Antero-posterior diameter of the bone, 1.5 mm.; lateral, 2 mm.

Antero-posterior diameter of the medullary canal, 1 mm.; lateral, 1.5 mm.

The medullary canal contains a very thin layer of marrow around the walls of the bone. Medullary index, 62%.

Structure.—The section is composed of lamellæ with long and narrow lacunæ and long, straight canaliculi. In the outer wall the lamellæ are interrupted by irregularly shaped whorls of oval and round lacunæ closely packed together in the bone substance. The canaliculi are short and bushy. In one of these whorls a central canal appears and the whole figure resembles slightly a crude Haversian system. A few large canals cross the section radially on their way from the medullary canal to the external surface. The bone is uniform.

Type I.

FEMUR OF MUS RATTUS. RAT. CR. MED. COLL.

PL. 9, FIG. 180. SYN. TAB. V

Antero-posterior diameter of bone, 2.5 mm.; lateral, 3.5 mm.

Antero-posterior diameter of the medullary canal, 1.5 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 75%.

Structure.—The section is composed of two concentric rings of about equal width surrounding the medullary canal. The external ring is composed of lamellæ with long lacunæ and long, branching canaliculi. Here and there cross canals appear. The internal ring is composed of short lamellæ, laminæ, and a few incomplete Haversian systems of the (Ib) differentiation, separated by a network of canals. The lacunæ are oval and round and the canaliculi are bushy. The internal circumferential lamellæ are so blended with the other structures of the internal ring that they are poorly defined.

Type I-III, Ib.

LEFT FEMUR OF HETEROMYS. SPINY POCKET RAT. AMER. MUS. NAT. HIST.

PL. 9, FIG. 181. SYN. TAB. V

Antero-posterior diameter of bone, 4.5 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 3.5 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 153%.

Structure.—The anterior and inner walls are composed of lamellæ with long and oval lacunæ and straight canaliculi, crossed radially by frequent canals. The posterior wall is composed of rather crude Haversian systems with oval lacunæ and bushy canaliculi, and the outer wall of lamellæ with oval lacunæ and bushy canaliculi, interrupted by crude Haversian systems of the (Ia) and (Ib) differentiations and crossed by canals. The internal circumferential lamellæ are not distinct. The bone shows but little differentiation of structure.

Type I-III, Ia, Ib.

RIGHT FEMUR OF MYOGALE MOSCHATA. DESMAN. CR. MED. COLL.

Pl. 9, Fig. 182. Syn. Tab. V

Antero-posterior diameter of bone, 5 mm.; lateral, 6.5 mm.

Antero-posterior diameter of medullary canal, 2.5 mm.; lateral, 3 mm.

Medullary canal has no contents. Medullary index, 30%.

Structure.—The inner wall of the bone is extended in the form of a ridge, which is composed of a network of laminæ and canals running transversely and occupying the outer four-fifths of the ridge. Each lamina is composed of lamellæ with long or oval lacunæ and long branching or bushy canaliculi. The inner one-fifth of the ridge wall is composed of a network of laminæ running from the medullary canal to the outer network. The remainder of the bone (anterior, outer, and posterior wall) is composed of a very irregular, wide internal ring of lamellæ surrounding the medullary canal and having an outer wavy border, in some places distinct and in other places fused with an external network of laminæ. Many canals cross the lamellæ on their way from the medullary canal to the middle of the wall. Within the lamellar ring are several round or elliptical bodies composed of lamellæ running lengthwise of the cross-section. These bodies are such as would result from a transverse section of solid pillars. In the outer wall of the bone lamellæ form the entire thickness. Here and there occur a few incomplete Haversian systems consisting of a central canal and radiating canaliculi. Twofold division.

Type I-II-III, Ib.

FEMUR OF CYNOMYS LUDOVICIANUS. PRAIRIE DOG. CR. MED. COLL.

Pl. 9, Fig. 183. Syn. Tab. V

Antero-posterior diameter of bone, 4.5 mm.; lateral, 5 mm.

Antero-posterior diameter of medullary canal, 2.5 mm.; lateral, 3 mm.

The medullary canal is empty. Medullary index, 50%.

Structure.—The section is composed of external circumferential lamellæ forming an irregular ring which reaches its greatest width in the inner wall. The lacunæ are long and narrow and the canaliculi are long.

The central ring is composed of incomplete Haversian systems of the (Ib) differentiation. Their lamellæ are indistinct, their lacunæ are oval, and their canaliculi are bushy.

A very wide ring of internal circumferential lamellæ surrounds the medullary canal. The ring is widest in the anterior wall. Their lacunæ are long and narrow and their canaliculi are long. Numerous canals pass from the medullary canal across the lamellæ into the interior of the bone.

Type I-III, Ib.

LEFT FEMUR OF TRICHOSURUS VULPECULA. PHALANGER. NO. 22804, AMER. MUS. NAT. HIST.

PL. 9, FIG. 184. SYN. TAB. V

Antero-posterior diameter of bone, 7 mm.; lateral, 7.5 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 61%.

Structure.—The section is composed of lamellæ with long lacunæ and straight canaliculi, interrupted by a few Haversian systems of the (Ia) and (Ib) differentiations and crossed radially by vascular canals.

The bone shows very little differentiation of structure. The bone is uniform.

Type I-III, Ia, Ib.

LEFT FEMUR OF PHASCOLOMYS URSINUS. WOMBAT. AMER. MUS. NAT. HIST.

PL. 9, FIG. 185. SYN. TAB. V

Antero-posterior diameter of bone, 11.5 mm.; lateral, 13 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 11%.

Structure.—The section is composed of several concentric rings of lamellæ with long lacunæ and straight canaliculi surrounding the medullary canal.

The rings of lamellæ are separated by small, crude Haversian systems of the (Ia) and (Ib) differentiations and crossed radially by many canals. The posterior ridge is double. The two ridges are composed of very crude Haversian systems and inter-Haversian lamellæ. Between them and forming the posterior wall the structure is the same as elsewhere.

The lacunæ are long and oval and the canaliculi are long, straight, or bushy. The bone shows but little differentiation of structure.

Type I-III, Ia, Ib.

RIGHT FEMUR OF LASIOPYGA KOLBI. AFRICAN MONKEY. NO. 27719, AMER. MUS. NAT. HIST.

PL. 9, FIG. 186. SYN. TAB. V

Antero-posterior diameter of bone, 8.5 mm.; lateral, 10 mm.

Antero-posterior diameter of medullary canal, 6 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 98%.

Structure.—The section is composed of concentric lamellæ with oval lacunæ and bushy canaliculi, interrupted by small crude Haversian systems of the (Ia) and (Ib) differentiation enclosing the medullary canal. A few fairly well developed Haversian systems appear in the inner wall and several are found in the posterior wall. The bone is uniform.

Type I-III, Ia, Ib.

RIGHT FEMUR OF TRAGULUS JAVANICUS. JAVA MOUSE-DEER. NO. 14128, AMER. MUS. NAT. HIST.

PL. 10. FIG. 187. SYN. TAB. V

Antero-posterior diameter of bone, 7.5 mm.; lateral, 7 mm.

Antero-posterior diameter of medullary canal, 6.5 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 289%.

Structure.—The section is composed of lamellæ with long lacunæ and straight canaliculi incompletely separated into laminæ, interrupted by a few Haversian systems of the (Ia) and (C) differentiations and crossed by canals. In the posterior wall Haversian systems are most numerous. The lacunæ are long and oval. The bone shows but little differentiation of structure.

Type II-III, Ia, C.

RIGHT FEMUR OF MUS SYLVATICUS. WOOD MOUSE. CR. MED. COLL.

PL. 10, FIG. 188. SYN. TAB. V

Antero-posterior diameter of bone, 2 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 50%.

Structure.—The section is composed of lamellæ with round, oval, and long lacunæ and bushy canaliculi, separated into short bands which extend spirally, concentrically, and radially along the walls. Here and there a few crude Haversian systems appear.

Type I-III, Ib.

LEFT FEMUR OF ERINACEUS EUROPÆUS. HEDGEHOG. AMER. MUS. NAT. HIST.

PL. 10, FIG. 189. SYN. TAB. V

Antero-posterior diameter of bone, 3 mm.; lateral, 6 mm.

Antero-posterior diameter of medullary canal, 2 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—With the exception of the anterior wall, the section is surrounded by bone substance with oval lacunæ and bushy canaliculi.

The body of the section is composed of bone substance with oval lacunæ and bushy canaliculi in which are Haversian systems of the (Ib) differentiation. In the anterior wall is a narrow concentric lamina. The posterior wall is very much extended and composed of cancellous bone substance with oval lacunæ. The internal circumferential lamellæ are absent.

Type I-III, Ib.

RIGHT FEMUR OF VIVERRA. CIVET. AMER. MUS. NAT. HIST.

PL. 10, FIG. 190. SYN. TAB. V

Antero-posterior diameter of bone, 8 mm.; lateral, 7 mm.

Antero-posterior diameter of medullary canal, 5 mm.; lateral, 4 mm.

The medullary canal is full. Medullary index, 55%.

Structure.—The section has three divisions. A wide ring of lamellæ, dimly separated into concentric parts and frequently interrupted by Haversian systems of the (Ia) differentiation, forms the greater part of the bone. The lacunæ are oval and the canaliculi are bushy and straight. Underneath this is a long crescent of Haversian systems of the (Ib) differentiation surrounding the section with the exception of the inner wall. The systems are separated by bone substance with round lacunæ and bushy canaliculi.

A narrow ring of lamellæ with long lacunæ and straight canaliculi surrounds the medullary canal.

Type I-III, Ia, Ib.

RIGHT FEMUR OF RATUFA MAXIMA. GIANT SQUIRREL. NO. 22839, AMER. MUS. NAT. HIST.

PL. 10, FIG. 191. SYN. TAB. V

Antero-posterior diameter of bone, 5.5 mm.; lateral, 6.5 mm.

Antero-posterior diameter of medullary canal, 3.5 mm.; lateral, 4.5 mm.

The medullary canal is full. Medullary index, 80%.

Structure.—The section is surrounded by a wide ring of lamellæ with long lacunæ and straight canaliculi, interrupted by Haversian systems of the (Ia) differentiation. In the posterior and outer wall is a narrow ring of small Haversian systems of the (Ib) differentiation. The internal circumferential lamellæ are not distinct.

Type I-III, Ia, Ib.

FEMUR OF GALEOPITHECUS. FLYING LEMUR. NO. 49640, U. S. NAT. MUS.

PL. 10, FIG. 192. SYN. TAB. V

Antero-posterior diameter of bone, 6.5 mm.; lateral, 5.5 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 3.5 mm.

The medullary canal is full. Medullary index, 64%.

Structure.—The section is composed of a wide ring of external circumferential lamellæ with long lacunæ and straight canaliculi, frequently interrupted by small, crude Haversian systems of the (Ia) differentiation. The lamellæ form the whole thickness of the anterior wall with the exception of the internal circumferential lamellæ.

The internal circumferential lamellæ, with a long, narrow crescent of Haversian systems of the (Ib) differentiation, especially in the posterior and adjacent lateral wall, surround the medullary canal.

Type I-III, Ia, Ib.

LEFT FEMUR OF MANIS. SCALY ANT-EATER. AMER. MUS. NAT. HIST.

PL. 10, FIG. 193. SYN. TAB. V

Antero-posterior diameter of bone, 7.5 mm.; lateral, 11 mm.

Antero-posterior diameter of medullary canal, 5 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 74%.

Structure.—The three divisions appear indistinctly marked. The external circumferential lamellæ with long lacunæ and straight canaliculi form a wide band around the section. They are interrupted by crude Haversian systems of the (Ia) differentiation and crossed by canals which assume a radial direction. Under this band is a narrow ring of lamellæ with oval lacunæ and bushy canaliculi. Beneath this again is a narrow ring of Haversian systems of the (Ib) differentiation. The lacunæ are oval and long and the canaliculi are bushy.

Internal circumferential lamellæ form a narrow ring around the medullary canal. Their lacunæ are oval. In the outer wall tendon insertions and crude systems are found. Threefold division.

Type I-III, Ia, Ib.

RIGHT FEMUR OF PROCAVIA CAPENSIS. CONEY. NO. 35326, AMER. MUS. NAT. HIST.

PL. 10, FIG. 194. SYN. TAB. V

Antero-posterior diameter of bone, 7.5 mm.; lateral, 5 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 25%.

Structure.—The external circumferential lamellæ form a narrow boundary of the posterior wall and then gradually widen to form the whole of the anterior wall. They are interrupted by Haversian systems of the (Ia) differentiation.

Their lacunæ are long and their canaliculi are straight. In the posterior half of the section the central ring borders the medullary surface of the posterior and inner wall and is discontinued as it reaches the anterior wall. It is composed of well developed Haversian systems. Internal circumferential lamellæ form a broken ring around the medullary canal.

Type I-III Ia, C.

LEFT FEMUR OF HELICTIS ORIENTALIS. ASIATIC BADGER. NO. 31806, AMER. MUS. NAT. HIST.

PL. 10, FIG. 195. SYN. TAB. V

Antero-posterior diameter of bone, 5.5 mm.; lateral, 4.5 mm.

Antero-posterior diameter of medullary canal, 3.2 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 129%.

Structure.—The section is composed of lamellæ frequently interrupted by Haversian systems and crossed by canals. The lamellæ have oval and long lacunæ and straight and bushy canaliculi.

Type I-III, C.

RIGHT FEMUR OF CYNOCEPHALUS. BABOON. NO. 35120, AMER. MUS. NAT. HIST.

PL. 10, FIG. 196. SYN. TAB. V

Antero-posterior diameter of bone, 16 mm.; lateral, 16 mm.

Antero-posterior diameter of medullary canal, 10 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 64%.

Structure.—The section is composed of a wide ring of external lamellæ, interrupted by small, crude Haversian systems of the (Ia) differentiation and by large spaces. The lacunæ are long and oval with long canaliculi. The ring forms nearly the whole width of the wall. Around the medullary canal the internal circumferential lamellæ form an enclosing ring which is partly cancellous. A few Haversian systems occur between the internal and external lamellæ. In the posterior ridge Haversian systems, separated by lamellæ with oval lacunæ, constitute the structure.

Type I-III, Ia, Ib.

RIGHT FEMUR OF CYNOCEPHALUS MAIMON. MANDRILL. NO. 22817, AMER. MUS. NAT. HIST.

PL. 10, FIG. 197. SYN. TAB. V

Antero-posterior diameter of bone, 13 mm.; lateral, 11.5 mm.

Antero-posterior diameter of medullary canal, 8 mm.; lateral, 8 mm.

The medullary canal is full. Medullary index, 75%.

Structure.—The section is composed of two parts: a wide external circumferential ring of lamellæ, interrupted by a few crude Haversian systems of the (Ia) and (Ib) differentiations, and a narrower internal ring of cancellous bone. The lacunæ are long and oval and their canaliculi are straight. The bone shows but little differentiation of structure.

Type I-III, Ia, Ib.

RIGHT FEMUR OF HYDROCHŒRUS CAPYBARA. NO. 35325, AMER. MUS. NAT. HIST.

PL. 10, FIG. 198. SYN. TAB. V

Antero-posterior diameter of bone, 22 mm.; lateral, 20 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 48%.

Structure.—The section is surrounded by a narrow ring of Haversian systems and inter-Haversian lamellæ. The central ring, confined to the outer wall, is composed of crude Haversian systems of the (Ib) differentiation, between which are lamellæ with large, oval lacunæ and bushy canaliculi in the outer wall, and lamellæ with oval lacunæ and bushy canaliculi interrupted by canals of the (Ia) differentiation in the inner and anterior wall. The internal circumferential lamellæ form a narrow ring round the medullary canal. The lacunæ are oval.

Type I-III, Ia, Ib.

Femora of Fetal Sheep, Calf, and Pig—Half Time

RIGHT FEMUR OF FETAL SHEEP, 11 WEEKS. NO. 93, CR. MED. COLL.

PL. 11, FIG. 199. SYN. TAB. V

Antero-posterior diameter of bone, 3.5 mm,; lateral, 4 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 1 mm.

The medullary canal is full. Medullary index, 8%.

Structure.—The section is composed of short, wide, irregular laminæ with oval lacunæ and bushy canaliculi, between which are short, wide, irregular communicating canals. The section is pretty uniform in structure. A few Haversian systems of the (Ib) differentiation are present in the posterior wall. This femur is about one-half of the full fetal term and may be compared with the human femur of 4 to 5 months.

Type II-III, Ib.

RIGHT FEMUR OF FETAL CALF, 18 WEEKS. NO. 94, CR. MED. COLL.

PL. 11, FIG. 200. SYN. TAB. V

Antero-posterior diameter of bone, 12 mm.; lateral, 11 mm.

Antero-posterior diameter of medullary canal, 5 mm.; lateral, 4 mm.

The medullary canal is full. Medullary index, 18%.

Structure.—The bone is half fetal development. It is composed of small, very irregular areas of laminæ separated by many canals of bizarre shapes. Around the circumferential fourth of the bone the canals are elongated and the laminæ have assumed a general concentric arrangement. In the medullary three-fourths there is no definite plan of arrangement. The laminæ are composed of oval and long lacunæ with rather infrequent canaliculi. Here and there, and especially in the posterior ridge, some laminæ have widened, shortened, and assumed in part the shape of Haversian systems.

Type II-III, Ib.

RIGHT FEMUR OF A FETAL PIG, HALF FETAL PERIOD—$8\frac{1}{2}$ WEEKS.

PL. 11, FIG. 201. SYN. TAB. V

Antero-posterior diameter of bone, 3.5 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 1 mm.

The medullary canal is situated eccentrically. The anterior wall is thinnest, the posterior thickest.

The medullary canal is full. Medullary index, 17%.

Structure.—The section is composed of concentric laminæ separated and crossed by wide canals. In the anterior wall the laminæ are short, in the lateral wall, long, and in the posterior wall, irregular. There are no Haversian systems, although in the posterior wall the laminæ are very short and inclined to a circular bend. The lacunæ are oval and the canaliculi are bushy.

Type II.

FEMUR OF CARIACUS MACROTIS. DEER. CR. MED. COLL.

PL. 11, FIG. 202. SYN. TAB. V

Antero-posterior diameter of bone, 25 mm.; lateral, 24 mm.

Antero-posterior diameter of the medullary canal, 17 mm.; lateral, 16.5 mm.

The medullary canal is full. Medullary index, 88%.

Structure.—The bone is composed almost entirely of laminæ. They are well developed, separated, and crossed by wide canals. Their lacunæ are long, narrow, and completely developed and the canaliculi are long and branching. Here and there are found a few aberrant Haversian systems, produced by a circular widening of the concentric canals and the bending of a few lamellæ around the circular openings. The laminæ form the entire section, excepting the posterior ridge and a small area near the anterior wall which are composed of Haversian systems with many oval lacunæ. There are no distinct external circumferential lamellæ. The canals between the laminæ cross them at right angles and communicate freely with each other.

The internal circumferential laminæ form an irregularly shaped boundary of the medullary canal. They are frequently crossed by canals extending outward from the medullary canal. The surface of the posterior ridge shows the tendon attachments of muscles. Extending from this surface to the internal circumferential laminæ, and for a short distance on either side of the posterior mid-line, is an area of Haversian systems. They are irregular in shape, well developed for the most part, separated by bone substance with oval lacunæ and bushy canaliculi, and surrounded by a coarse network of canals. Their lacunæ are long and narrow, generally. A few, however, show round or oval lacunæ with short, bushy canaliculi. The bone is uniform.

Type II-III, C.

FEMUR OF SUS. DOMESTIC PIG. CR. MED. COLL.

PL. 11, FIG. 203. SYN. TAB. V

Antero-posterior diameter of bone, 21.5 mm.; lateral, 18.5 mm.

Antero-posterior diameter of medullary canal, 16.5 mm.; lateral, 12.5 mm.

The medullary canal is full. Medullary index, 108%.

Structure.—The bone, with the exception of the posterior wall, is composed of concentric laminæ. The laminæ are separated and crossed by wide canals which frequently communicate with each other. The separating canals, here and there, widen into circular areas which are surrounded by incompletely developed concentric lamellæ and form aberrant Haversian systems. The laminæ are long or short and strongly developed. They have long, narrow lacunæ and branching canaliculi. In the posterior wall are two areas of well developed Haversian systems separated by an intermediate wall of laminæ. These are the only regular systems of the section.

The femur of the adult pig is second type with two areas of Haversian systems in the posterior wall. This bone, therefore, is essentially second in type as it emerges from the fetal stage, and, for the most part, remains second in the adult.

Type II-III, C.

RIGHT FEMUR OF SUS SCROFA. WILD BOAR. (ARKANSAS.) CR. MED. COLL.

PL. 11, FIG. 204. SYN. TAB. V

Antero-posterior diameter of bone, 23 mm.; lateral, 20 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 13 mm.

The medullary canal is full. Medullary index, 74%.

Structure.—The bone is composed of concentric laminæ crossed and divided into short segments by canals. The laminæ are composed of lamellæ with long narrow lacunæ and straight canaliculi.

In the posterior wall are two ridges separated by the intervening portion of the posterior wall. These ridges are composed of well developed Haversian systems which occupy the whole thickness of the wall from the external laminæ to the internal. Between the ridges the posterior wall is composed of laminæ alternating with Haversian systems in concentric rows. About the middle of the lateral walls on both sides of the two ridges, crude Haversian systems are extended for some distance between the laminæ. The lacunæ of all units are well developed.

Type II-III, C.

FEMUR OF ALCES MACHLIS. ELK. CR. MED. COLL.

PL. 11, FIG. 205. SYN. TAB. V

Antero-posterior diameter of bone, 35 mm.; lateral, 33 mm.

Antero-posterior diameter of medullary canal, 23 mm.; lateral, 20 mm.

The medullary canal is full. Medullary index, 66%.

Structure.—A ring of external circumferential lamellæ surrounds the bone. Their lacunæ are long and narrow and their canaliculi are long and branching. The central ring, constituting the greater part of the bone, is composed of fully developed laminæ separated by concentric canals and interrupted at short intervals by completely developed Haversian systems. The laminæ are frequently transected by the canals, which freely communicate with each other. They are composed of lamellæ with long, narrow lacunæ and branching canaliculi. They have the appearance of a strong development. The canals are wide and in some places have widened into Haversian canals.

The Haversian systems have long, narrow lacunæ and long branching canaliculi. The Haversian canals are large, round or oval in shape, and freely communicate with each other. Beginning in the posterior wall, and extending around the outer wall, nearly to the anterior mid-line, and occupying a position next to the internal circumferential lamellæ, is a narrow zone of Haversian systems. Another group is found near the surface of the anterior wall, and near the medullary canal are several large vascular canals surrounded by lamellæ.

Type II-III, C.

RIGHT FEMUR OF CAMELUS. CAMEL. NO. 35379, AMER. MUS. NAT. HIST.

PL. 11, FIG. 206. SYN. TAB. V

Antero-posterior diameter of bone, 51 mm.; lateral, 50 mm.

Antero-posterior diameter of medullary canal, 35 mm.; lateral, 35 mm.

The medullary canal is full. Medullary index, 93%.

Structure.—The section is composed of concentric laminæ crossed by numerous canals. Their lacunæ are oval and long and their canaliculi are bushy and straight. Near the medullary border the laminæ are interrupted by numerous irregularly shaped spaces. The posterior ridge is composed of Haversian systems of the (Ib) differentiation. Around the medullary surface these are separated by large, irregularly shaped spaces.

Type II-III, Ib.

RIGHT FEMUR OF AUCHENIA GLAMA. LLAMA. NO. 36363, AMER. MUS. NAT. HIST.

PL. 11, FIG. 207. SYN. TAB. V

Antero-posterior diameter of bone, 25 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal. 17 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index. 69%.

Structure.—The section is composed of short and long concentric laminæ with long lacunæ and straight canaliculi, separated and crossed by canals and frequently interrupted by small Haversian systems of the (Ib) differentiation. The posterior ridge is composed of Haversian systems. Around the medullary canal are many irregularly shaped spaces.

Type II-III, Ib.

RIGHT FEMUR OF RANGIFER. REINDEER. NO. 4176, U. S. NAT. MUS.

PL. 11, FIG. 208. SYN. TAB. V

Antero-posterior diameter of bone, 26 mm.; lateral, 23 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 60%.

Structure.—Beginning on both sides of the posterior ridge and extending around the section is a horseshoe band of laminæ with long lacunæ and straight canaliculi, frequently interrupted by small, crude Haversian systems of the (Ia) differentiation. The band constitutes the whole width of the wall with the exception of the narrow internal circumferential lamellæ. The posterior ridge is composed of Haversian systems—(Ib differentiation). The medullary canal is surrounded by a ring of lamellæ.

Type II-III, Ia, Ib.

LEFT FEMUR OF URSUS AMERICANUS. BLACK BEAR. CR. MED. COLL.

PL. 12, FIG. 209. SYN. TAB. V

Antero-posterior diameter of bone, 31 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 22 mm.; lateral, 21 mm.

The medullary canal is full. Medullary index, 105%.

Structure.—The bone is nearly round and has thin walls. The anterior wall is thickest. The bone is composed of short and long laminæ having a general concentric arrangement, but presenting a variety of positions in the different portions of the wall. In the anterior and outer wall they are short and long, having the curvature of the bone, or present short angular curves and run transversely. The laminæ are quite uniform in width and are separated by distinctly wide canals. The lacunæ are long and the canaliculi are straight.

In the posterior wall the laminæ are interrupted by a few Haversian systems well developed. In the inner wall the laminæ are more uniformly concentric.

Type II.

RIGHT FEMUR OF TAUROTRAGUS ORYX. ELAND. NO. 27891, AMER. MUS. NAT. HIST.

PL. 12, FIG. 210. SYN. TAB. V

Antero-posterior diameter of bone, 55 mm.; lateral, 44 mm.

Antero-posterior diameter of medullary canal, 35 mm.; lateral, 30 mm.

The medullary canal is full. Medullary index, 73 %.

Structure.—The section is composed entirely of laminæ with the exception of the posterior ridge. They are short in the anterior wall and of varying lengths in the lateral wall. Their lacunæ are generally oval and their canaliculi are straight. The posterior ridge is composed of irregular Haversian systems, separated by bone substance with oval lacunæ and bushy canaliculi.

Type II.

LEFT FEMUR OF CONNOCHÆTES TAURINUS ALBOJUBATUS. GNU. NO. 27824, AMER. MUS. NAT. HIST.

PL. 12, FIG. 211. SYN. TAB. V

Antero-posterior diameter of bone, 33.5 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 20 mm.; lateral, 17.5 mm.

The medullary canal is full. Medullary index, 53%.

Structure.—With the exception of the posterior ridge the section is composed of short and long laminæ. The laminæ are composed of lamellæ with oval lacunæ and straight canaliculi and are separated and crossed by canals.

The ridge is composed of fairly well developed Haversian systems, separated by short lamellæ with oval lacunæ and bushy canaliculi.

Type II.

RIGHT FEMUR OF OVIBOS MOSCHATUS WARDI. MUSK OX. AMER. MUS. NAT. HIST.

PL. 12, FIG. 212. SYN. TAB. V

Antero-posterior diameter of bone, 36 mm.; lateral, 34 mm.

Antero-posterior diameter of medullary canal, 30 mm.; lateral, 28 mm.

The medullary canal is full. Medullary index, 219%.

Structure.—The section is composed of laminæ with oval lacunæ and straight canaliculi, separated by concentric canals. The laminæ are short and long, and interrupted here and there by small Haversian systems of the (Ib) differentiation. The posterior ridge is composed of small Haversian systems.

In the inner lateral wall is another aggregation of the same type of Haversian systems.

Type II-III, Ib.

RIGHT FEMUR OF MEXICAN BURRO. CR. MED. COLL.

PL. 12, FIG. 213. SYN. TAB. V

Antero-posterior diameter of bone, 30 mm.; lateral, 23 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 31%.

Structure.—The section is composed of concentric laminæ, separated and crossed by canals, and interrupted by crude and fairly well developed Haversian systems. Several laminæ extend from the anterior to the posterior wall along the medullary surface of the inner wall. The internal circumferential lamellæ with long lacunæ and straight canaliculi form a narrow boundary of the medullary canal. Haversian systems occupy the mid-line of the posterior ridge.

Type II.

RIGHT FEMUR OF TAPIRUS. TAPIR. NO. 35181, AMER. MUS. NAT. HIST.

PL. 12, FIG. 214. SYN. TAB. VI

Antero-posterior diameter of bone, 32 mm.; lateral, 35 mm.

Antero-posterior diameter of medullary canal, 21 mm.; lateral, 25 mm.

The medullary canal is full. Medullary index, 98%.

Structure.—The section is composed of laminæ interrupted by two groups of Haversian systems, one in the posterior outer ridge and the other in the posterior inner ridge. In the anterior wall a few systems also appear. The lacunæ are oval, the canaliculi bushy, and cross canals are infrequent. A little cancellous bone is seen in the anterior wall. The Haversian systems of the posterior wall are separated by considerable inter-Haversian lamellæ.

Type II-III, C.

LEFT FEMUR OF EQUUS HEMIONUS. WILD ASS OF ASIA. NO. 49493, U. S. NAT. MUS.

PL. 12, FIG. 215. SYN. TAB. VI

Antero-posterior diameter of bone, 46 mm.; lateral, 31 mm.

Antero-posterior diameter of medullary canal, 26 mm.; lateral, 19 mm.

The medullary canal is full. Medullary index, 55%.

Structure.—Beginning on both sides of the posterior ridge and constituting the entire thickness of the wall of the bone are laminæ which are interrupted by small Haversian systems, and also alternate with Haversian systems. The systems are most numerous in the posterior wall. There is nearly an equal concentric division of the laminæ. In the external portion they follow a regular concentric course; while in the internal they form two wide crescent-shaped bands around the medullary canal. In the mid-line of the anterior wall the systems are arranged in a narrow column from one surface to the other.

The posterior ridge is composed of Haversian systems, large, small, and irregular in shape. Internal circumferential lamellæ in a narrow ring enclose the medullary canal.

Type II-III, C.

RIGHT FEMUR OF ELEPHAS AFRICANUS. AFRICAN ELEPHANT. NO. 35185, AMER. MUS. NAT. HIST.

PL. 12, FIG. 216. SYN. TAB. VI

Antero-posterior diameter of bone, 108 mm.; lateral, 83 mm.

Antero-posterior diameter of medullary canal, 65 mm.; lateral, 49 mm.

The medullary canal is full. Medullary index, 55%.

Structure.—With the exception of a very narrow fragmentary ring of external circumferential lamellæ with long lacunæ and straight canaliculi, the section is composed almost entirely of Haversian systems of the (C) differentiation. Inter-Haversian lamellæ are present in some portions of the bone. The systems form the external boundary of the inner anterior wall where the lamellæ are deficient. Numerous cross canals unite the systems. The lacunæ of the whole section are long and narrow and their canaliculi are long, straight, and thickly set. The internal circumferential lamellæ are fragmentary.

Type III, C.

FEMUR OF CHOLŒPUS DIDACTYLUS. TWO-TOED SLOTH. NO. 104593, U. S. NAT. MUS.

PL. 12, FIG. 217. SYN. TAB. VI

Antero-posterior diameter of bone, 16 mm.; lateral, 11 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 4 mm.

The medullary canal is cancellous. Medullary index, 9%.

Structure.—The section has a long posterior ridge and exhibits the three structural divisions. The external circumferential lamellæ form a narrow ring around the bone excepting at the posterior ridge. The lacunæ are long with straight canaliculi in some places and oval with bushy canaliculi in others.

The central ring is composed of very distinct Haversian systems with little inter-Haversian lamellæ. They are of a high structural type. Their lacunæ are long and their canaliculi are long and straight. Some of the Haversian systems are united by cross canals, but not many. The systems are well developed but many, especially around the medullary canal, show senile changes.

The internal circumferential lamellæ take the form of a thick ring of cancellous bone. The lacunæ are well developed.

Type III, C, senile.

RIGHT FEMUR OF POTOS CAUDIVOLVULUS. KINKAJOU. AMER. MUS. NAT. HIST.

PL. 12, FIG. 218. SYN. TAB. VI

Antero-posterior diameter of bone, 7 mm.; lateral, 8 mm.

Antero-posterior diameter of medullary canal, 4.5 mm.; lateral, 5.5 mm.

The medullary canal is full. Medullary index, 80%.

Structure.—The section has three divisions. The external circumferential lamellæ form a narrow band around the anterior and lateral wall. Their lacunæ are oval and their canaliculi are straight. The central ring is composed of Haversian systems and inter-Haversian lamellæ with oval lacunæ and bushy canaliculi. The ring forms the inner wall with the exception of the internal lamellæ. The internal circumferential lamellæ form a ring around the medullary canal.

Type III, C.

RIGHT FEMUR OF LUTRA CANADENSIS. OTTER. NO. 30191, AMER. MUS. NAT. HIST.

PL. 12, FIG. 219. SYN. TAB. VI

Antero-posterior diameter of bone, 14.5 mm.; lateral, 11 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 28%.

Structure.—The external circumferential lamellæ appear in fragments. The central ring constitutes nearly the whole section and is composed of well developed Haversian systems. In the posterior wall the systems are separated by lamellæ with oval lacunæ and straight canaliculi. The internal circumferential lamellæ surround the medullary canal and form a wide band in the outer wall.

Type III, C.

RIGHT FEMUR OF SIMIA SATYRUS. ORANG-UTAN. (BORNEO.) NO. 154304, U. S. NAT. MUS.

PL. 13, FIG. 220. SYN. TAB. VI

Antero-posterior diameter of bone, 20 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 11 mm.; lateral, 16 mm.

The medullary canal is full. Medullary index, 41%.

Structure.—The external circumferential lamellæ are deficient in a portion of the anterior wall, the Haversian systems of the central ring reaching the surface at this point. The lamellæ begin to increase in thickness as they pass around the inner wall where they form nearly one-third of its width. They then diminish in thickness as they reach the posterior wall, then slightly increase in the outer wall, and finally disappear as they approach the anterior wall. In this manner they form a complete ring with the exception of a small anterior portion of the circumference. They are interrupted by vascular canals and Haversian canals of the (Ia) differentiation.

The central ring is composed of well developed Haversian systems separated here and there by short lamellæ. The systems are small and large, but well developed. Their lacunæ are long and narrow. The systems are frequently united by cross canals. The internal circumferential lamellæ form a complete ring of varying widths around the medullary canal.

The femur of the orang-utan resembles the human femur more closely than those of other apes or monkeys.

Type I-III, Ia, C.

LEFT FEMUR OF FELIS TIGRIS. TIGER. NO. 174981, U. S. NAT. MUS.

PL. 13, FIG. 221. SYN. TAB. VI

Antero-posterior diameter of bone, 28 mm.; lateral, 22 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 41%.

Structure.—The posterior ridge is composed of well developed Haversian systems. Beginning on both sides of the ridge and extending around the section is a horseshoe band of lamellæ with long lacunæ and straight canaliculi, interrupted by Haversian systems of the (Ia) differentiation. The central ring is composed of well developed Haversian systems. The internal circumferential lamellæ with long lacunæ and straight canaliculi form a wide irregular ring around the medullary canal. The ring is crossed by numerous radiating canals.

Type I-III, Ia, C.

RIGHT FEMUR OF HEMIGALUS HARDWICKI. CIVET CAT. NO. 32358, AMER. MUS. NAT. HIST.

PL. 13, FIG. 222. SYN. TAB. VI

Antero-posterior diameter of bone, 7 mm.; lateral, 5.5 mm.

Antero-posterior diameter of medullary canal, 4.5 mm.; lateral, 3 mm.

The medullary canal is full. Medullary index, 54%.

Structure.—The three divisions are well marked. The external circumferential lamellæ form a wide ring around the bone. It is crossed by canals and interrupted by a few crude Haversian systems of the (Ia) differentiation. Its lacunæ are long and the canaliculi are straight. The central ring is composed of well developed Haversian systems with very little inter-Haversian lamellæ. The internal circumferential lamellæ form a narrow ring around the medullary canal. The lacunæ are long and the canaliculi are straight.

Type I-III, Ia, C.

RIGHT FEMUR OF TATU NOVEMCINCTUS. ARMADILLO. NO. 357, AMER. MUS. NAT. HIST.

PL. 13, FIG. 223. SYN. TAB. VI

Antero-posterior diameter of bone, 7.5 mm.; lateral, 16 mm.

Antero-posterior diameter of medullary canal, 5 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The section has a long lateral diameter by extension of its outer wall. It is composed of lamellæ with oval and round lacunæ and bushy canaliculi, crossed in all directions by canals and interrupted by a few undeveloped Haversian systems of the (Ib) differentiation. The outer process has central cancellous bone.

Type I-III, Ib.

RIGHT FEMUR OF TAMANDUA TETRADACTYLA. ANT-EATER. NO. 14866, AMER. MUS. NAT. HIST.

PL. 13, FIG. 224. SYN. TAB. VI

Antero-posterior diameter of bone, 7 mm.; lateral, 12 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 4 mm.

The medullary canal is full. Medullary index, 17%.

Structure.—The longest diameter of the bone is its lateral diameter. The outer wall is projected outward into a prominent ridge. Beginning on both sides of the mid-line of the inner wall and extending around the section is a band of external circumferential lamellæ, interrupted in the anterior wall by concentrically arranged small, crude Haversian systems of the (Ia) differentiation, and in the posterior wall by a few fairly well developed Haversian systems. The band is widest in the anterior wall and narrowest in the outer wall. The lacunæ are oval and long and the canaliculi are bushy and straight.

Under this band is a central ring of Haversian systems of the (Ib) differentiation, between which is bone substance with oval and large lacunæ and bushy canaliculi. The ring nearly reaches the external surface at the mid-line of the inner wall. The systems are united by cross canals. Internal circumferential lamellæ form a rather narrow ring around the medullary canal. In the outer and inner wall it assumes a cancellous form.

Type I-III, Ia, Ib.

LEFT FEMUR OF GORILLA. GORILLA. NO. 22832, AMER. MUS. NAT. HIST.

PL. 13, FIG. 225. SYN. TAB. VI

Antero-posterior diameter of bone, 16.5 mm.; lateral, 19.5 mm.

Antero-posterior diameter of medullary canal, 7.5 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 15%.

Structure.—Beginning on both sides of the posterior ridge and extending around the external aspect of the bone is a wide horseshoe-shaped band of lamellæ with long and oval lacunæ and straight and bushy canaliculi. The lamellæ are interrupted by crude Haversian systems of the (Ia) differentiation and crossed at various angles by numerous canals.

The central ring is composed of well developed Haversian systems and inter-Haversian lamellæ. Their lacunæ are long and canaliculi are straight. The ring is narrow in the anterior wall and widens as it encircles the lateral and posterior wall. In the posterior ridge the systems form the whole thickness of the wall and are embraced by the heel of the horseshoe band. The internal circumferential lamellæ form a narrow ring around the medullary canal.

More than half of the section is lamellar. In this respect it differs from the orang-utan in the femur of which the external lamellæ form a narrower ring.

Type I-III, Ia, C.

FEMUR OF PRESBYTIS RUBICUNDA. MONKEY. NO. 153793, U. S. NAT. MUS.

PL. 13, FIG. 226. SYN. TAB. VI

Antero-posterior diameter of bone, 11 mm.; lateral, 11 mm.

Antero-posterior diameter of medullary canal, 6 mm.; lateral, 6.5 mm.

The medullary canal is full. Medullary index, 48%.

Structure.—A wide irregularly shaped horseshoe of lamellæ surrounds the section. The lamellæ form about one-half of the thickness of the inner and anterior wall and practically the whole thickness of the outer wall. They are well developed with narrow lacunæ and long canaliculi and are frequently interrupted by Haversian canals of the (Ia) differentiation.

The central ring is interrupted by the external lamellæ of the outer wall. It is narrow and composed of fairly well developed Haversian systems with considerable inter-lamellar structure. The posterior ridge is composed of lamellæ and Haversian systems mixed. The systems have oval and narrow lacunæ and rather infrequent canaliculi. The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-III, Ia, C.

RIGHT FEMUR OF HYLOBATES. GIBBON. NO. 111988, U. S. NAT. MUS.

PL. 13, FIG. 227. SYN. TAB. VI

Antero-posterior diameter of bone, 11 mm.; lateral, 11.5 mm.

Antero-posterior diameter of medullary canal, 6 mm.; lateral, 6.5 mm.

The medullary canal is full. Medullary index, 44%.

Structure.—The section of the bone is composed of a wide external ring of lamellæ, frequently interrupted by very incomplete Haversian systems of the (Ia) differentiation. The lamellar ring surrounds the bone with the exception of the posterior ridge, where a few Haversian systems reach the external surface and blend with a few tendon insertions.

The central ring is composed of Haversian systems of the (C) differentiation which displace the internal circumferential lamellæ in the outer lateral wall and border on the medullary canal. Their lacunæ and canaliculi are well developed. The internal circumferential lamellæ surround the medullary canal excepting a small part of the outer lateral wall.

Type I-III, Ia, C.

LEFT FEMUR OF ANTHROPOPITHECUS TROGLODYTES. CHIMPANZEE. NO. 18010, AMER. MUS. NAT. HIST.

PL. 13, FIG. 228. SYN. TAB. VI

Antero-posterior diameter of bone, 13 mm.; lateral, 16 mm.

Antero-posterior diameter of medullary canal, 6 mm.; lateral, 8 mm.

The medullary canal is full. Medullary index, 30%.

Structure.—The external circumferential lamellæ surround the section. This lamellar ring is widest in the antero-inner lateral wall where it constitutes nearly the whole thickness of the wall. It is narrowest in the posterior wall. Its lamellæ have long lacunæ with straight canaliculi. The ring is interrupted by crude Haversian systems of the (Ia) differentiation and crossed by canals.

The central ring, irregular in width, is composed of well developed Haversian systems.

The internal circumferential lamellæ form a narrow ring around the medullary canal. Just external to this ring is a concentric row of vascular spaces. The lacunæ are long.

The bone is, however, more than half lamellæ.

Type I-III, Ia, C.

RIGHT FEMUR OF MACACUS RHESUS. INDIAN MONKEY. R. I.

PL. 14, FIG. 229. SYN. TAB. VI

Antero-posterior diameter of bone, 8 mm.; lateral, 8.5 mm.

Antero-posterior diameter of medullary canal, 5 mm.; lateral, 5.5 mm.

The medullary canal is full. Medullary index, 68%.

Structure.—There are no external and internal circumferential lamellæ distinct from the central ring of the bone.

A crescent of well developed Haversian systems, bordering upon the inner wall of the medullary canal, begins in the posterior region and extends around the inner and anterior to the outer wall, where it merges into the lamellar structure. The widest part of the crescent forms about one-third of the entire thickness of the inner wall.

The systems are well developed. In several places a half system borders the medullary canal. The lacunæ are long and narrow and their canaliculi are long and branching. The Haversian systems are frequently united by short inter-Haversian lamellæ. A second crescent of Haversian systems borders the medullary canal extending from the posterior prominence around the posterior and outer to about the middle portion of the anterior wall. The systems of the two crescents are the only fully developed systems present. The second crescent is narrower than the first. Its widest part is in the posterior region of the outer wall. The lacunæ are long and narrow and the canaliculi are straight.

The main structure of the inner, anterior, and outer wall is lamellar. It is composed of irregularly concentric lamellæ, interrupted by rudimentary Haversian systems of the (Ib) differentiation. This lamellar structure makes up practically the whole bone. The lacunæ are generally long, and have long, branching, and numerous canaliculi. In some places the lacunæ are curved and quite irregular in shape. The posterior wall and ridge is composed of Haversian systems, poorly developed. They are separated by lamellæ. Their outlines are not sharply defined, but appear to merge into the surrounding lamellæ.

Type I-III, Ib, C.

RIGHT FEMUR OF SCIURUS SP. (LARGE RED SQUIRREL.) CR. MED. COLL.

PL. 14, FIG. 230. SYN. TAB. VI

Antero-posterior diameter of bone, 4.5 mm.; lateral, 6 mm.

Antero-posterior diameter of the medullary canal, 3.5 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 18%.

Structure.—A ring of external circumferential lamellæ of varying widths surrounds the bone. Their lacunæ are mostly long and narrow and their canaliculi are numerous, long, and branching. A central, irregularly shaped ring of complete and incomplete Haversian systems is situated under the external lamellæ. It increases in thickness around the inner, posterior, and outer wall, and reaches the surface in the outer wall. In many places in the inner wall the systems are composed of oval lacunæ with short, bushy canaliculi arranged in a circular manner.

Internal circumferential lamellæ form an uneven, thick ring around the medullary canal. Their lacunæ are long and narrow and their canaliculi are long, numerous, and branching. The bone, therefore, is composed of three very uneven and irregularly shaped rings of structural units.

Type I-III, Ib, C.

RIGHT FEMUR OF FELIS. DOMESTIC CAT. CR. MED. COLL.

PL. 14. FIG. 231. SYN. TAB. VI

Antero-posterior diameter of bone, 7.5 mm.; lateral, 9.5 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 5.5 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—External circumferential lamellæ form more than one-half of the thickness of the wall of the bone. A few Haversian systems appear in the middle portion of the lamellar ring. They are well developed and without apparent signification. A short distance from the mid-line in the inner wall the lamellar ring divides into a wide outer and a narrow inner part which encloses a crescent shaped area of Haversian systems. About the middle of the inner wall is quite a sharp lateral ridge. The lamellar ring is widest at this point and narrowest in the outer wall. The lacunæ are long and narrow and the canaliculi are thickly set, long, and branching.

The central ring is composed of well developed, large and small Haversian systems, widest in the inner wall and narrowest in the outer wall. The systems are generally strongly developed, and are round, elliptical, or irregular in cross-section.

The internal circumferential lamellæ are in the form of laminæ. Their lacunæ are long or oval and their canaliculi are bushy. Numerous canals pass through the laminæ on their way from the medullary canal. Four femora of the domestic cat were examined and in each one there was a different development, structure, and arrangement of bone units.

Type I-II-III, C.

LEFT FEMUR OF FELIS CATUS. WILD CAT. CR. MED. COLL.

PL. 14. FIG. 232. SYN. TAB. VI

Antero-posterior diameter of bone, 13.5 mm.; lateral, 11 mm.

Antero-posterior diameter of the medullary canal, 8 mm.; lateral, 5.5 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—Around the outside of the bone is a ring of lamellæ, interrupted very frequently by incomplete Haversian systems of the (Ib) differentiation. The ring forms a greater part of the thickness of the wall of the bone excepting in the posterior wall, where the Haversian systems occupy the whole width from the internal circumferential lamellæ outward to the circumference. Many canals traverse the ring. For the most part, all of the structural units are rather indistinct. Around the anterior and a portion of the inner wall is a narrow rim of external lamellæ. The lacunæ of the lamellar ring are long or oval and their canaliculi are long and branching or bushy.

The central ring is incomplete, occupying the posterior, inner, and anterior walls. It is composed of well developed Haversian systems, crossed in the anterior wall by an extension from the external lamellæ. It is wide in the posterior wall and gradually narrows as it passes around the lateral into the anterior wall.

Around the medullary canal is a well defined ring of internal circumferential lamellæ. Numerous large canals cross the ring to communicate with canals within the center of the bone. The lacunæ are long and canaliculi long and branched.

Type I-III, Ib, C.

FEMUR OF MEPHITIS MEPHITICA. SKUNK. CR. MED. COLL.

PL. 14, FIG. 233. SYN. TAB. VI

Antero-posterior diameter of bone, 5 mm.; lateral, 5 mm.

Antero-posterior diameter of medullary canal, 3.5 mm.; lateral, 4 mm.

The medullary canal is full. Medullary index, 127%.

Structure.—The section is composed of lamellæ with long lacunæ and straight and bushy canaliculi, frequently interrupted by irregularly shaped Haversian systems and canals. Some of the systems are round, some oval, and some have long, wide, straight, or curved canals. In some situations they are concentric. As a whole, they are well developed. There is no well defined central ring nor internal circumferential lamellæ.

Type I-III, C.

FEMUR OF PUTORIUS VISON. MINK.

PL. 14, FIG. 234. SYN. TAB. VI

Antero-posterior diameter of bone, 3.5 mm.; lateral, 4.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 2 mm.

The medullary canal is full. Medullary index, 23%.

Structure.—The anterior wall is composed of lamellæ which form its entire thickness. The lamellæ then form an irregularly shaped, complete ring around the medullary canal. Numerous canals pass across this ring, incompletely or completely, on their way from the medullary canal to small canals of the interior. The lacunæ are long and narrow and their canaliculi are long and branching.

The Haversian systems are absent at the widest lamellar point of the anterior wall. They then begin to appear in single file, gradually increase in thickness to the posterior wall, and diminish again as they approach the anterior wall. In this manner they form an irregular long crescent enclosed within lamellæ. The crescent nearly encircles the bone. The Haversian systems are well developed, their lacunæ are oval, and their canaliculi are relatively few. Their canals frequently unite. In some places bands of lamellæ cross the crescent extending from the outer to the inner lamellæ. Numerous canals traverse the crescent. The internal circumferential lamellæ form a wide, irregular ring, fusing with the external lamellæ in the anterior wall. The lacunæ are long and narrow and their canaliculi are long and branching.

Type I-III, C.

LEFT FEMUR OF CRYPTOPROCTA FEROX. CAT-LIKE CIVET. AMER. MUS. NAT. HIST.

PL. 14, FIG. 235. SYN. TAB. VI

Antero-posterior diameter of bone, 8.5 mm.; lateral, 8 mm.

Antero-posterior diameter of medullary canal, 4.5 mm.; lateral, 4.5 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—The section is surrounded by a ring of external lamellæ of varying widths. It is interrupted by numerous canals of the (Ia) differentiation. The lacunæ are long and the canaliculi are straight. The ring is distinct from the underlying central ring of Haversian systems, which are well developed. The medullary canal is surrounded by internal circumferential lamellæ of varying widths.

Type I-III, Ia, C.

RIGHT FEMUR OF HYÆNA CROCUTA. HYÆNA. NO. 35431, AMER. MUS. NAT. HIST.

PL. 14, FIG. 236. SYN. TAB. VI

Antero-posterior diameter of bone, 14 mm.; lateral, 18 mm.

Antero-posterior diameter of medullary canal, 9 mm.; lateral, 13.5 mm.

The medullary canal is full. Medullary index, 98%.

Structure.—External lamellæ form a wide ring around the section with the exception of the outer ridge. The lamellæ are crossed by canals, interrupted by crude Haversian systems of the (Ia) differentiation, and have long lacunæ and straight canaliculi.

The central ring is composed of well developed Haversian systems with some inter-Haversian lamellæ. The systems form the whole of the outer ridge, where they are separated by bone substance with many oval lacunæ and bushy canaliculi.

A narrow ring of internal circumferential lamellæ surrounds the medullary canal. The lacunæ are long.

Type I-III, Ia, C.

RIGHT FEMUR OF THYLACINUS CYNOCEPHALUS. TASMANIAN WOLF

PL. 14, FIG. 237. SYN. TAB. VI

Antero-posterior diameter of bone, 19.5 mm.; lateral, 15 mm.

Antero-posterior diameter of medullary canal, 8 mm.; lateral, 8.5 mm.

The medullary canal is full. Medullary index, 28%.

Structure.—The section is surrounded by a narrow ring of external lamellæ, interrupted here and there by crude Haversian systems of the (Ia) differentiation. Underneath this ring is a wide horseshoe of lamellæ, interrupted by many crude Haversian systems of the (Ia) differentiation arranged concentrically. The outer wall is all lamellæ.

Underneath this band is a central, incomplete ring of well developed Haversian systems with inter-Haversian lamellæ. In the posterior wall the systems form nearly the whole of the wall. Here the oval large lacunæ with bushy canaliculi are pronounced.

Internal circumferential lamellæ form a narrow ring around the medullary canal. Their lacunæ are long.

Type I-III, Ia, C.

RIGHT FEMUR OF DASYPROCTA AGOUTI. NO. 15669, AMER. MUS. NAT. HIST.

PL. 14, FIG. 238. SYN. TAB. VI

Antero-posterior diameter of bone, 10 mm.; lateral, 8 mm.

Antero-posterior diameter of medullary canal, 6.5 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 93%.

Structure.—The three divisions are well marked. A wide ring of external circumferential lamellæ, interrupted by crude Haversian systems of the (Ia) differentiation and crossed by canals, surrounds the section with the exception of the posterior ridge. The lamellar ring forms more than half of the section. The central ring is composed of well developed Haversian systems with inter-Haversian lamellæ.

The systems of the central ring reach the surface at the posterior ridge where they are separated by bone substance with oval lacunæ. The internal circumferential lamellæ form a narrow ring around the medullary canal. The lacunæ are long in the external and internal lamellæ; elsewhere they are oval.

Type I-III, Ia, C.

LEFT FEMUR OF LASIOPYGA CENTRALIS JOHNSTONI. AFRICAN MONKEY. NO. 27705, AMER. MUS. NAT. HIST.

PL. 14, FIG. 239. SYN. TAB. VI

Antero-posterior diameter of bone, 9 mm.; lateral, 8 mm.

Antero-posterior diameter of medullary canal, 5.5 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 62%.

Structure.—The section has three divisions. A wide ring of external circumferential lamellæ, interrupted by Haversian systems of the (Ia) differentiation, surrounds the bone. In the posterior wall it is interrupted by irregularly shaped Haversian systems. Canals cross the ring at various intervals. The lacunæ are long and narrow and the canaliculi are straight.

The central ring is very narrow and composed of a few well developed Haversian systems with inter-Haversian lamellæ.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-III, Ia, C.

RIGHT FEMUR OF FELIS CANADENSIS. CANADA LYNX. CR. MED. COLL.

PL. 15, FIG. 240. SYN. TAB. VI

Antero-posterior diameter of bone, 13 mm.; lateral, 12 mm.

Antero-posterior diameter of medullary canal, 9.5 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 121%.

Structure.—The usual three structural rings are distinct. The external circumferential lamellæ form a wide ring around the section excepting at the ridges of the inner and posterior wall where they are deficient. They are interrupted by small, crude Haversian systems of the (Ia) differentiation; while in the posterior wall much better developed systems form an important part of the whole lamellar ring.

The central ring is composed of well developed Haversian systems with very little inter-Haversian structure. At the ridges the systems break through the external circumferential lamellæ and form the external surface of the bone at these points.

The internal circumferential lamellæ form a narrow ring around the medullary canal excepting a small portion of the posterior and inner wall. The lacunæ in all parts are well developed.

Type I-III, Ia, C.

RIGHT FEMUR OF LASIOPYGA SP. AFRICAN MONKEY.
NO. 163283, U. S. NAT. MUS.

PL. 15, FIG. 241. SYN. TAB. VI

Antero-posterior diameter of bone, 5.5 mm.; lateral, 5 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—External circumferential lamellæ of varying widths surround the bone. In the anterior and inner wall they form two-thirds of the thickness of the section and in the posterior and outer wall about one-fourth of the entire thickness. They are frequently interrupted by crude Haversian systems of the (Ia) differentiation and crossed at various angles by short canals. Their lacunæ and canaliculi are well developed. The central ring is composed of well developed Haversian systems and lamellæ with systems of the (Ia) differentiation. The ring is widest in the outer lateral wall.

In the lamellar portion of the ring are one or two concentric rows of small Haversian canals which gradually change into the more completely developed Haversian systems of the outer wall. The internal circumferential lamellæ surround the medullary canal excepting in the outer wall. The lamellar and Haversian portions of the section are about equal.

Type I-III, Ia, C.

RIGHT FEMUR OF MIDAS RUFONIGER. SOUTH AMERICAN MONKEY (UPPER AMAZON). NO. 14548, U. S. NAT. MUS.

PL. 15, FIG. 242. SYN. TAB. VI

Antero-posterior diameter of bone, 4.5 mm.; lateral, 4 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 74%.

Structure.—The three structural rings are distinctly marked. The external circumferential lamellæ form a thick enclosing ring of one-third to one-half the thickness of the wall of the bone. The lamellæ of the inner wall are very frequently dotted with small, clear, round spaces which are not present in the outer wall. The lacunæ are well developed.

The central ring is composed of rather irregularly shaped but well developed Haversian systems, separated by inter-Haversian lamellæ. They are frequently united by canals. The internal circumferential lamellæ form a narrow ring around the medullary canal, excepting in the outer wall where they are deficient.

Type I-III, Ia, C.

LEFT FEMUR OF LEMUR. NO. 84383, U. S. NAT. MUS.

PL. 15, FIG. 243. SYN. TAB. VI

Antero-posterior diameter of bone, 10 mm.; lateral, 8.5 mm.

Antero-posterior diameter of medullary canal, 5.5 mm.; lateral, 4.5 mm.

The medullary canal is full. Medullary index, 41%.

Structure.—The section is surrounded by a lamellar ring which is widest in the anterior and posterior wall. In the inner wall it is divided into laminæ, and frequently interrupted by canals and very crude Haversian systems of the (Ia) differentiation. The lacunæ are generally well developed. The central ring, of varying widths, is composed of fairly well developed Haversian systems, small, large, and irregular in shape, and frequently united by canals. Their lacunæ are well developed. In the anterior wall the ring is divided into two nearly equal parts by a narrow, crescent-shaped lamina, the horns of which begin about the middle of the lateral walls. The internal circumferential lamellæ surround the medullary canal. It is widest in the inner wall and well developed.

Type I-III, Ia, C.

RIGHT FEMUR OF LEMUR CATTA. RING-TAILED LEMUR. U. S. NAT. MUS.

PL. 15, FIG. 244. SYN. TAB. VI

Antero-posterior diameter of bone, 8.5 mm.; lateral, 7 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 4.5 mm.

The medullary canal is full. Medullary index, 122%.

Structure.—The section is surrounded by a heavy, dark ring of varying widths composed of meshed bone work. The meshes are irregular in shape and size. The ring is narrowest in the outer wall, widest in the inner and antero-lateral, and of intermediate thickness in other situations. The meshes are filled with dense material which adheres to the mesh walls even in extremely thin places. The mesh walls are extensions of the external circumferential lamellæ.

Underneath this ring is a wide lamellar ring, interrupted by cross and longitudinal canals and crude Haversian systems of the (Ia) and (Ib) differentiations. In the posterior wall the ring is wide and coarsely lamellar and frequently interrupted by large, irregular spaces. Underneath this is an irregularly shaped ring of fairly well developed Haversian systems with numerous spaces. The internal circumferential lamellæ surround the medullary canal. It is widest in the anterior and lateral walls.

Type I-III, Ia, Ib, C.

LEFT FEMUR OF ATELES. SPIDER-MONKEY. (TEHUANTEPEC.) NO. 11842, U. S. NAT. MUS.

PL. 15, FIG. 245. SYN. TAB. VI

Antero-posterior diameter of bone, 12.5 mm.; lateral, 10.5 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 5.5 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—The external circumferential lamellæ form a wide ring surrounding the section, excepting a small portion of the inner wall. The lamellæ are frequently interrupted by Haversian canals of the (Ia) differentiation and small Haversian systems. The ring is widest in the posterior wall. The central ring is composed of well developed Haversian systems with some inter-Haversian lamellæ. The systems displace the external circumferential lamellæ in the anterior portion of the inner wall where they form the external boundary of the bone.

The internal circumferential lamellæ surround the medullary canal. They are most prominent in the inner wall. The lacunæ of the three rings are well developed.

Type I-III, Ia, C.

RIGHT FEMUR OF CALLICEBUS TORQUATUS. SQUIRREL-MONKEY. NO. 105539, U. S. NAT. MUS.

PL. 15, FIG. 246. SYN. TAB. VI

Antero-posterior diameter of bone, 5.5 mm.; lateral, 5 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 3.5 mm.

The medullary canal is full. Medullary index, 104%.

Structure.—The anterior and outer half of the section is surrounded by a wide band of external circumferential lamellæ, interrupted by Haversian canals of the (Ia) differentiation, underneath which is a narrow half ring of Haversian systems bordering upon the medullary canal. The lacunæ of the lamellæ and Haversian systems are oval and long and the canaliculi are generally long and straight.

The posterior and inner half of the section is composed of irregularly shaped Haversian systems forming the whole thickness of the posterior and inner wall. The external and internal circumferential lamellæ are not distinct from the remaining structure.

Type I-III, Ia, C.

LEFT FEMUR OF GENETTA. GENET. NO. 163294, U. S. NAT. MUS.

PL. 15, FIG. 247. SYN. TAB. VI

Antero-posterior diameter of bone, 9 mm.; lateral, 7 mm.

Antero-posterior diameter of medullary canal, 6.5 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 107%.

Structure.—A ring of external circumferential lamellæ of varying widths surrounds the section. In the anterior wall it forms nearly the whole thickness; it then becomes narrow in the outer wall, remains about the same width in the posterior wall, and again widens in the inner anterior wall. It is interrupted by crude Haversian systems of the (Ia) differentiation in the anterior, inner, and posterior wall. The lacunæ are oval and long, and the canaliculi are long and straight. Underneath the lamellar ring is an irregular ring of Haversian systems well developed. The ring is widest in the lateral and posterior wall. The systems are irregular in shape in the outer wall. Their lacunæ are oval and the canaliculi are straight. An incomplete ring of internal circumferential lamellæ surrounds the medullary canal.

Type I-III, Ia, C.

LEFT FEMUR OF PEDETES. JUMPING HARE. U. S. NAT. MUS.

PL. 15, FIG. 248. SYN. TAB. VI

Antero-posterior diameter of bone, 10.9 mm.; lateral, 9 mm.

Antero-posterior diameter of medullary canal, 7.5 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 85%.

Structure.—The bone is surrounded by a lamellar ring of varying widths. The lamellæ are frequently interrupted by small, crude Haversian systems of the (Ia) differentiation and crossed by a few canals. The lacunæ are oval and narrow and the canaliculi are bushy and straight. Underneath the lamellæ is an irregular ring of Haversian systems separated by lamellæ and canals. The systems are fairly well developed. In the inner wall the systems are interrupted by a few laminæ. The internal circumferential lamellæ form a ring of varying widths around the medullary canal. Their lacunæ are narrow and the canaliculi are straight.

Type I-III, Ia, C.

RIGHT FEMUR OF BRADYPUS TRIDACTYLUS. THREE-TOED SLOTH. NO. 16871, AMER. MUS. NAT. HIST.

PL. 15, FIG. 249. SYN. TAB. VI

Antero-posterior diameter of bone, 8.5 mm.; lateral, 13 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 4 mm.

The medullary canal is full. Medullary index, 12%.

Structure.—The section has three divisions. The external circumferential lamellæ form a wide rim around the bone. It is crossed radially by numerous canals and interrupted frequently by normal and senile Haversian systems and by Haversian canals of the (Ia) differentiation. The band of lamellæ constitutes half of the wall. The lacunæ are oval and long and the canaliculi are straight.

The central ring is composed of complete and senile Haversian systems. Various stages and degrees of senility are found. Some systems are entirely gone; some occur in narrow rings; some show precipitation of inorganic material around the Haversian canal; and some show the whole systems involved but still in position. Their lacunæ are long and oval. The internal circumferential lamellæ assume a cancellous form around the medullary canal. Their lacunæ are long and the canaliculi are straight.

The bone exhibits a much greater lamellar structure than the femur of the two-toed sloth. It is quite different in shape. Senility is marked.

Type I-III, Ia, C, senile.

RIGHT FEMUR OF CASTOR CANADENSIS. BEAVER. NO. 10005, U. S. NAT. MUS.

PL. 16, FIG. 250. SYN. TAB. VI

Antero-posterior diameter of bone, 25 mm.; lateral, 11 mm.

Antero-posterior diameter of medullary canal, 6 mm.; lateral, 4 mm.

The medullary canal is full. Medullary index, 10%.

Structure.—The section has a long posterior ridge, which accounts for the long antero-posterior and short lateral measurements. The section is surrounded by a lamellar and laminar band of varying widths, interrupted by Haversian canals of the (Ia) differentiation and crossed by frequent vascular canals. The lacunæ are oval and long and the canaliculi are straight.

Underneath the lamellæ is a narrow band of irregular Haversian systems. The systems are large and small, but very well developed. They are quite irregular in shape. Their canals frequently unite. The central part of the ridge is composed of large Haversian systems, poorly developed and united by vascular canals. The internal circumferential lamellæ assume the form of cancellous bone around the medullary canal.

Type I-II-III, Ia, Ib, C.

LEFT FEMUR OF FELIS. LEOPARD. NO. 35349, AMER. MUS. NAT. HIST.

PL. 16, FIG. 251. SYN. TAB. VI

Antero-posterior diameter of bone, 18 mm.; lateral, 17 mm.

Antero-posterior diameter of medullary canal, 10 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 37%.

Structure.—The section has three divisions. A wide band of lamellæ and Haversian systems surrounds the bone. It is widest in the inner wall. The systems are numerous and do not appear to have any definite plan of arrangement. The lacunæ are long and the canaliculi are straight. The central ring, irregular in width, is composed of well developed Haversian systems with little inter-Haversian lamellæ. The internal circumferential lamellæ form a fragmentary ring around the medullary canal. Many spaces occur which appear to be the result of the disappearance of Haversian systems. Senile changes are frequent.

Type I-III, C, senile.

LEFT FEMUR OF BOS. DOMESTIC OX. CR. MED. COLL.

PL. 16, FIG. 252. SYN. TAB. VI

Antero-posterior diameter of bone, 44 mm.; lateral, 39 mm.

Antero-posterior diameter of medullary canal, 23 mm.; lateral, 21 mm.

The medullary canal is full. Medullary index, 40%.

Structure.—The bone is composed of three wide concentric rings with irregular boundaries, separated by canals containing chains of black lacunar-like bodies with connecting and very irregular canalicular extensions. In thin sections there appear to be no uniting structures in the canals of sufficient importance to hold the rings together.

The canals have an undulating course and communicate with other canals of the rings.

External or first ring: This ring is composed of concentric laminæ divided into short lengths. Occasionally a few Haversian systems interrupt the laminæ. In the anterior wall the laminæ are transformed into irregular Haversian systems which have their best development in the middle portion of the walls. The laminæ have long or oval lacunæ and branching or bushy canaliculi. Some laminæ are solid; some have central canals; and some show these canals enlarged at intervals with the lamellæ bending around the enlargements, forming aberrant Haversian systems.

Middle or second ring: The borders of the separating canals are composed of clear lamellæ with no visible canaliculi. The second ring is composed of short and long laminæ arranged vertically to the outer ring, especially in the inner wall. Along the outer border of the separating canal the lamina is concentric. As it approaches the anterior projecting wall it merges into the irregular Haversian systems of that region. In the outer wall the laminæ are much more concentric. The laminæ of this ring are folded around canalicular expansions into elliptical or elongated angular Haversian systems. As they approach the third ring they are more circular. Their lacunæ and canaliculi are like those of the outer ring.

Internal or third ring: This is composed of vertical and concentric laminæ of an Haversian system character intermixed. There are more systems in the posterior wall, and it is here that they are best developed. The laminæ of this ring run in various directions and form complex arrangements of structural units. The anterior wall of the bone is composed of irregularly shaped, large, crude Haversian systems united by short lamellæ. Around the medullary canal is an irregular ring of internal circumferential lamellæ having long, narrow lacunæ with branching canaliculi.

Type II-III, C.

LEFT FEMUR OF EQUUS CABALLUS. DOMESTIC HORSE. CR. MED. COLL.

PL. 16, FIG. 253. SYN. TAB. VI

Antero-posterior diameter of bone, 57.5 mm.; lateral, 41.5 mm.

Antero-posterior diameter of medullary canal, 32 mm.; lateral, 22.5 mm.

The medullary canal is full. Medullary index, 43%.

Structure.—The section is composed of rings of well developed Haversian systems alternating with laminæ. It has more Haversian systems than laminæ. The external circumferential lamellæ are fragmentary. The Haversian systems reach the external boundary, and in some places half-systems are present with their Haversian canals directly underneath the periosteum. The Haversian systems vary in diameter and are well developed. Their lacunæ are long and their canaliculi are long and branching. Commencing in the outer posterior region a few laminæ appear, which increase in number as they approach the posterior wall. The laminæ are well developed and are separated by Haversian systems. Internal circumferential lamellæ form a narrow ring around the medullary canal and become cancellous in the posterior wall.

Type II-III, C.

RIGHT FEMUR OF OVIS. DOMESTIC SHEEP. CR. MED. COLL.

PL. 16, FIG. 254. SYN. TAB. VI

Antero-posterior diameter of bone, 18 mm.; lateral, 14 mm.

Antero-posterior diameter of medullary canal, 10.7 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 44%.

Structure.—External circumferential laminæ surround the section. The lacunæ are long and narrow with long, branching canaliculi. Between the external laminæ and internal circumferential lamellæ are small and large Haversian systems, arranged in the form of a crescent and situated in the outer, posterior, and inner lateral wall. The thickest portion of the crescent is in the outer wall. The systems are, for the most part, small, close together, and their Haversian canals frequently unite. They have few lacunæ and few bushy canaliculi. The inner wall of the bone is composed almost entirely of laminæ, there being a few Haversian systems close to the internal circumferential lamellæ. The laminæ are separated by wide canals which frequently cross and unite with other canals. Each lamina is composed of lamellæ with oval lacunæ and bushy canaliculi. The inner wall of the bone has oblique laminæ. Internal circumferential lamellæ surround the medullary canal.

Type II-III, C.

RIGHT FEMUR OF BISON AMERICANUS. BISON. NO. 22914, AMER. MUS. NAT. HIST.

PL. 16, FIG. 255. SYN. TAB. VI

Antero-posterior diameter of bone, 56 mm.; lateral, 46 mm.

Antero-posterior diameter of medullary canal, 39 mm.; lateral, 33 mm.

The medullary canal is full. Medullary index, 100%.

Structure.—The bone is chiefly composed of laminæ. There are two aggregations of Haversian systems, one in the posterior ridge and the other in the angle of the inner wall. They are fairly well developed and occupy nearly the whole thickness of the wall. Their lacunæ are oval. The remainder of the section is composed of laminæ, interrupted by small Haversian systems. The lacunæ are oval and the canaliculi are straight.

Type II-III, C.

RIGHT FEMUR OF A MULE. NO. 227, CR. MED. COLL.

PL. 16, FIG. 256. SYN. TAB. VI

Antero-posterior diameter of bone, 60 mm.; lateral, 55 mm.

Antero-posterior diameter of medullary canal, 47 mm.; lateral, 45 mm.

The medullary canal is full. Medullary index, 179%.

Structure.—The section shows a posterior and outer ridge. The posterior ridge is composed of small Haversian systems and inter-Haversian lamellæ with oval lacunæ and bushy canaliculi. Many spaces occur and the laminæ are crossed by numerous short canals. The outer ridge consists of Haversian systems and laminæ and shows a large number of spaces. Between these two ridges the wall is composed of Haversian systems and laminæ. The remainder of the section is composed of laminæ, interrupted by Haversian systems and crossed by canals. Half of the anterior and inner walls is composed of laminæ perforated with spaces. The spaces have no walls but those of adjoining laminæ. They appear to be the result of senile changes. The bone is thin and fragile.

Type II-III, C, senile.

LEFT FEMUR OF A MULE. NO. 229, CR. MED. COLL.

PL. 16, FIG. 257. SYN. TAB. VI

Antero-posterior diameter of bone, 68 mm.; lateral, 50 mm.

Antero-posterior diameter of medullary canal, 40 mm.; lateral, 37 mm.

The medullary canal is full. Medullary index, 77%.

Structure.—The section has three ridges, a posterior ridge and one on either side of the anterior wall. The posterior ridge is composed of short lamellæ with branching canals, having a direction toward the point of the ridge.

Between the lamellæ are some Haversian systems. The lacunæ are oval and the canaliculi are straight. The anterior and inner ridges are composed of a few crude Haversian systems, laminæ, and branching canals. The anterior and outer ridges have many more Haversian systems and relatively fewer canals than the inner ridge. Between the three ridges the walls are composed of laminæ, interrupted by a few Haversian systems. The laminæ are frequently crossed by canals. Some cancellous bone appears on the medullary surfaces of the anterior and posterior walls.

Type II-III, C.

LEFT FEMUR OF A MULE. NO. 235, CR. MED. COLL.

PL. 16, FIG. 258. SYN. TAB. VI

Antero-posterior diameter of bone, 65 mm.; lateral, 51 mm.

Antero-posterior diameter of medullary canal, 38 mm.; lateral, 40 mm.

The medullary canal is full. Medullary index, 85%.

Structure.—The posterior wall is over half cancellous. The posterior ridge is composed of Haversian systems, inter-Haversian lamellæ with oval lacunæ and many branching canals, having a direction toward the external surface of the ridge. The remaining wall is composed of laminæ, interrupted by Haversian systems and crossed by numerous canals. In the outer wall near the mid-line is a collection of Haversian systems forming a slight ridge. Around the medullary canal in the anterior and lateral walls there are many spaces of irregular shape which appear to be the result of senile changes. The lacunæ are generally oval.

Type II-III, C, senile.

LEFT FEMUR OF A MULE. NO. 236, CR. MED. COLL.

PL. 16, FIG. 259. SYN. TAB. VI

Antero-posterior diameter of bone, 61 mm.; lateral, 50 mm.

Antero-posterior diameter of medullary canal, 40 mm.; lateral, 38 mm.

The medullary canal is full. Medullary index, 100%.

Structure.—The posterior ridge is composed of Haversian systems and inter-Haversian lamellæ with oval lacunæ. There are many short, branching canals having a direction toward the external surface. About one-third of the medullary portion of the wall is cancellous bone. The inner and anterior wall is composed of laminæ, interrupted by many Haversian systems. The systems are more numerous around the medullary canal. Many cross canals appear between the systems and extend across the laminæ. The anterior half of the outer wall is nearly all laminæ which are interrupted by Haversian systems. The posterior half is composed of irregular elongated Haversian systems and of laminæ. The femur of the mule differs from the horse in its predominating proportion of laminæ and in the frequent senile changes present in its scattering Haversian systems. The difference between the horse and the mule is found in the jackass.

Type II-III, C.

LEFT FEMUR OF ELEPHAS INDICUS. ASIATIC ELEPHANT. AMER. MUS. NAT. HIST.

PL. 17, FIG. 260. SYN. TAB. VII

Antero-posterior diameter of bone, 121 mm.; lateral, 77 mm.

Antero-posterior diameter of medullary canal, 50 mm.; lateral, 38 mm.

The medullary canal is full. Medullary index, 25%.

Structure.—The section is composed of lamellæ, laminæ, and Haversian systems, the laminæ predominating. The posterior ridge is composed of Haversian systems with inter-Haversian lamellæ. Beginning in the inner side of the ridge and extending around the external surface of the posterior inner wall is a wide band of lamellæ, frequently interrupted by Haversian systems. The lamellæ soon separate into laminæ as they extend around the section. The laminæ, frequently interrupted by Haversian systems and crossed by canals, complete the circumference of the bone to the posterior ridge. In the anterior wall they constitute two-thirds, in the inner wall one-third, and in the outer and posterior wall over half the width of the wall. As they approach the ridge they shorten and widen into elongated Haversian systems. Thus a wide horseshoe of lamellæ and laminæ surrounds the bone. In the anterior wall the toe of this shoe is very narrow, having been displaced by Haversian systems. The lacunæ and canaliculi are well developed. Underneath the laminar shoe is an irregularly shaped central ring of well developed Haversian systems with some senile changes around the medullary canal. The lacunæ are well developed. Around the medullary canal is an enclosing ring of lamellæ in the form of cancellous bone.

The bone is over half laminæ and lamellæ, and exhibits a different type of structure from that seen in the African elephant.

Type II-III, C, senile.

RIGHT FEMUR OF HIPPOPOTAMUS AMPHIBUS. HIPPOPOTAMUS

PL. 17, FIG. 261. SYN. TAB. VII

Antero-posterior diameter of bone, 70 mm.; lateral, 70 mm.

Antero-posterior diameter of medullary canal, 26 mm.; lateral, 30 mm.

The medullary canal is full. Medullary index, 19%.

Structure.—Beginning on the outer side of the posterior ridge and extending around the bone to the inner wall is a wide band of laminæ, interrupted by

Haversian systems of the (Ia) and (C) differentiations. The laminæ, separated and crossed by canals, form nearly the whole width of the outer, about one-third of the anterior, and terminate somewhat abruptly at the junction of the anterior and inner wall. The lacunæ are oval and the canaliculi are straight.

Underneath the laminar band is a central, irregularly shaped ring of Haversian systems, very narrow in the outer, wider in the anterior, and forming the whole of the inner and posterior wall. The systems are united by cross canals and exhibit some senile changes. Their lacunæ are oval and the canaliculi are straight.

Around the medullary canal is a cancellous ring of lamellæ. The bone is composed of about equal parts of Haversian systems and laminæ. The bone is unusually hard.

Type II-III, Ia, C.

LEFT FEMUR OF GIRAFFA CAMELOPARDALIS. GIRAFFE. NO. 27752, AMER. MUS. NAT. HIST.

PL. 17, FIG. 262. SYN. TAB. VII

Antero-posterior diameter of bone, 72 mm.; lateral, 59 mm.

Antero-posterior diameter of medullary canal, 35 mm.; lateral, 30 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—Beginning in the outer wall, close to the posterior ridge and extending around the section to about the middle of the inner wall, is a wide band of laminæ, interrupted frequently by Haversian systems. The band forms the external half of the posterior, all of the outer, and two-thirds of the anterior and inner wall. The laminæ are separated and crossed by canals. Their lacunæ are well developed.

The whole posterior, inner lateral, and medullary portions of the anterior and posterior lateral wall are composed of Haversian systems with the exception of the internal circumferential lamellæ. The systems vary somewhat in size and are well developed. In the posterior wall they are separated by aggregations of oval lacunæ closely packed together.

Internal circumferential lamellæ with long lacunæ and straight canaliculi, widest in the outer wall, surround the medullary canal.

Type II-III, C.

LEFT FEMUR OF RHINOCEROS BICORNIS. RHINOCEROS. NO. 27757, AMER. MUS. NAT. HIST.

PL. 17, FIG. 263. SYN. TAB. VII

Antero-posterior diameter of bone, 47.5 mm.; lateral, 130 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 23 mm.

The medullary canal is full. Medullary index, 55%.

Structure.—The bone is extended laterally and outwardly by a very prominent, wide, curved process, occupying the middle portion of the femur. Only a few femora have such a process. For convenience in description the section may be divided into a body containing the medullary canal and adjoining middle portion and a curved cancellous process.

The body is composed of Haversian systems which form the entire inner wall and of Haversian systems and laminæ which form the anterior and posterior wall. The systems vary in size, communicate by cross canals, and have oval lacunæ with straight canaliculi. Around the medullary region they show senile changes and greater irregularity. Laminæ begin to appear in the anterior and posterior wall and rapidly displace the systems as they reach the middle portion. The middle portion is composed of long laminæ separated by wide canals. In the center, crude Haversian systems and short laminæ are found. The canals communicate with the medullary canal and with the cancellous spaces of the curved process. The lacunæ are oval and the canaliculi are bushy. The curved process is composed of narrow, bordering lamellæ with small Haversian systems, enclosing a wide central portion of cancellous bone, the spaces of which are relatively large. The spaces communicate with the long canals of the middle portion and also with the medullary canal. Internal circumferential lamellæ form an irregularly shaped ring around the medullary canal. Their lacunæ are oval. The bone exhibits predominating laminæ and Haversian systems with oval lacunæ and bushy and straight canaliculi. Haversian systems are found only in the inner half of the body.

Type II-III, C, senile.

RIGHT FEMUR OF EQUUS BURCHELLI GRANTI. ZEBRA. NO. 27749, AMER. MUS. NAT. HIST.

PL. 17, FIG. 264. SYN. TAB. VII

Antero-posterior diameter of bone, 43 mm.; lateral, 37 mm.

Antero-posterior diameter of medullary canal, 20 mm.; lateral, 22 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—Three divisions are present. External circumferential lamellæ, frequently interrupted by Haversian systems, extend from the lateral boundaries of the posterior wall around the section. The lacunæ are oval and long. The systems are well developed.

The central ring is composed of a wide, horseshoe-shaped band of laminæ, interrupted in the anterior wall by groups of well developed Haversian systems. The lacunæ are oval and long and the canaliculi are straight.

The internal circumferential lamellæ form an enclosing ring around the medullary canal. In the anterior and posterior wall it takes the form of cancellous bone. The lacunæ are oval and long.

The posterior wall is composed entirely of Haversian systems of the (C) differentiation.

Type II-III, C.

LEFT FEMUR OF URSUS MARITIMUS. POLAR BEAR. NO. 35085, AMER. MUS. NAT. HIST.

PL. 17, FIG. 265. SYN. TAB. VII

Antero-posterior diameter of bone, 31 mm.; lateral, 38 mm.

Antero-posterior diameter of medullary canal, 18 mm.; lateral, 22 mm.

The medullary canal is full. Medullary index, 51%.

Structure.—The section has a rather peculiar shape. With the exception of the posterior ridge it is surrounded by laminæ, which, in the anterior wall, merge into lamellæ and are interrupted by Haversian systems. The central ring is composed of concentric rows of well developed Haversian systems alternating with laminæ, excepting in the posterior ridge which is all Haversian systems.

Internal circumferential lamellæ form a narrow ring around the medullary canal. The bone is more highly differentiated than the femur of the black bear.

Type II-III, C.

RIGHT FEMUR OF BUBALIS JACKSONI. HARTEBEEST. NO. 37815, AMER. MUS. NAT. HIST.

PL. 17, FIG. 266. SYN. TAB. VII

Antero-posterior diameter of bone, 32.5 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 16 mm.

The medullary canal is full. Medullary index, 39%.

Structure.—The section is composed mostly of laminæ. Around the bone is a wide horseshoe band of laminæ, interrupted by Haversian systems. The band forms the whole of the outer and anterior walls. Underneath the band in the inner wall is a narrow crescent of well developed Haversian systems. The posterior wall is composed of Haversian systems and short laminæ, between which are several vascular canals. A narrow ring of internal circumferential lamellæ, slightly wider in the inner wall, surrounds the medullary canal. The lacunæ are long and oval.

Type II-III, C.

LEFT FEMUR OF PHACOCHŒRUS AFRICANUS. WARTHOG. NO. 27762, AMER. MUS. NAT. HIST.

PL. 17, FIG. 267. SYN. TAB. VII

Antero-posterior diameter of bone, 24 mm.; lateral, 20.5 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 52%.

Structure.—A wide horseshoe band of laminæ surrounds the bone with the exception of the posterior ridge. The inner and outer portions of the posterior wall are composed entirely of laminæ. The anterior and lateral walls are about one half laminæ. The laminæ are long and short, have oval lacunæ and bushy canaliculi. The central ring is incomplete. It is composed of a crescent of well developed Haversian systems in the anterior and lateral wall. The systems are separated by short, oblique lamellæ. The posterior ridge is composed of Haversian systems of the (Ib) differentiation, between which lamellæ with oval lacunæ are prominent.

The internal circumferential lamellæ are fragmentary. The bone shows differentiation of structure in its laminæ and systems.

Type II-III, Ib, C.

LEFT FEMUR OF FELIS CONCOLOR. PANTHER. NO. 1492, AMER. MUS. NAT. HIST.

PL. 18, FIG. 268. SYN. TAB. VII

Antero-posterior diameter of bone, 16 mm.; lateral, 19 mm.

Antero-posterior diameter of medullary canal, 11 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 76%.

Structure.—The external circumferential lamellæ appear only in the posterior and in the inner lateral wall. The central ring constitutes the principal part of the section. In the inner anterior wall the ring is divided into two equal portions by a narrow concentric lamina. The ring is composed of well developed Haversian systems. The internal circumferential lamellæ form a ring of varying widths around the medullary canal. It is widest in the outer wall.

Type I-II-III, C.

LEFT FEMUR OF GULO LUSCUS. WOLVERENE. NO. 22884, AMER. MUS. NAT. HIST.

PL. 18, FIG. 269. SYN. TAB. VII

Antero-posterior diameter of bone, 10 mm.; lateral, 11.5 mm.

Antero-posterior diameter of medullary canal, 5.5 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 31%.

Structure.—A wide ring of lamellæ and crude laminæ interrupted by Haversian systems surrounds the section with the exception of a small portion of the outer wall. It is frequently crossed by canals. The lacunæ are long and the canaliculi are straight.

The central ring is somewhat incomplete and composed of well developed Haversian systems. It reaches the surface in the outer wall. A ring of laminæ interrupted by a few Haversian systems surrounds the medullary canal.

Type I-II-III, C.

LEFT FEMUR OF ERIGNATHUS BARBATUS. SEAL. NO. 19347, AMER. MUS. NAT. HIST.

PL. 18, FIG. 270. SYN. TAB. VII

Antero-posterior diameter of bone, 19.5 mm.; lateral, 39 mm.

Antero-posterior diameter of medullary canal, 10 mm.; lateral, 25 mm.

The medullary canal is full. Medullary index, 50%.

Structure.—Three divisions are present. The external circumferential lamellæ form a narrow enclosing ring. The lacunæ are oval.

The central ring is composed of well developed Haversian systems, short laminæ, and lamellæ with cross canals intermixed. It shows no plan of arrangement, but a confusing mixture of units. The lacunæ are oval and long and the canaliculi are straight. The ring constitutes nearly all of the section. The internal circumferential lamellæ form an incomplete ring around the medullary canal. In the lateral walls the lamellæ take the cancellous form. The planless arrangement of its three units is somewhat significant.

Type II-III, C.

LEFT FEMUR OF BOS BUBALIS. WATER BUFFALO. NO. 27770, AMER. MUS. NAT. HIST.

PL. 18, FIG. 271. SYN. TAB. VII

Antero-posterior diameter of bone, 48 mm.; lateral, 45 mm.

Antero-posterior diameter of medullary canal, 24 mm.; lateral, 25 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—Beginning on the inner side of the posterior and extending around the inner, anterior, and a portion of the outer wall is a wide band of laminæ, short and long, crossed by a great number of branching canals and interrupted in the anterior and outer wall by a few Haversian systems. Underneath this band in the inner and anterior wall is a crescent of Havesian systems and lamellæ with oval lacunæ and bushy canaliculi. The crescent is crossed by numerous canals. The outer wall is composed of Haversian systems and short laminæ and the posterior wall of Haversian systems and inter-Haversian lamellæ with oval lacunæ and bushy canaliculi. The medullary canal is surrounded by a narrow ring of internal circumferential lamellæ.

Type II-III, Ib, C.

LEFT FEMUR OF OVIS MONTANA. MOUNTAIN SHEEP. CR. MED. COLL.

PL. 18, FIG. 272. SYN. TAB. VII

Antero-posterior diameter of bone, 20 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 12.5 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 60%.

Structure.—The bone is composed of short concentric laminæ enclosing the medullary canal, with the exception of the crescent of Haversian systems in the anterior and an area of Haversian systems in the posterior wall. A single concentric lamina divides the section into two parts. Each lamina is composed of a few lamellæ with well developed lacunæ and canaliculi. There is a crescent of well developed Haversian systems in the anterior wall bordering upon the internal circumferential lamellæ. The posterior wall is composed of well developed Haversian systems extending from the external surface of the bone to the internal circumferential lamellæ. A narrow ring of internal circumferential lamellæ with long lacunæ and straight canaliculi surrounds the medullary canal.

Type II-III, C.

FEMUR OF CEPHALOPHUS AFRICAN ANTELOPE. NO. 163255, U. S. NAT. MUS.

PL. 18, FIG. 273. SYN. TAB. VII

Antero-posterior diameter of bone, 15 mm.; lateral, 13.5 mm.

Antero-posterior diameter of medullary canal, 9 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 67%.

Structure.—The bone is composed of a wide horseshoe band of laminæ embracing the posterior ridge. The laminæ are long and short and are interrupted by a few Haversian canals in the external laminæ. They are crossed by numerous canals from the medullary canal. Their lacunæ are long and their canaliculi are straight. Underneath the laminæ and adjacent to the internal circumferential lamellæ is a narrow ring of Haversian systems. The systems form nearly the whole posterior ridge, and elsewhere are situated between the canals extending outward from the medullary canal. They are well developed. The medullary canal is surrounded by a narrow ring of internal circumferential lamellæ well developed.

Type II-III, C.

FEMUR OF RAPHICEROS. STEINBOK. NO. 164801, U. S. NAT. MUS.

PL. 18, FIG. 274. SYN. TAB. VII

Antero-posterior diameter of bone, 12 mm.; lateral, 12.5 mm.

Antero-posterior diameter of medullary canal, 6.5 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 43%.

Structure.—The section is surrounded by a narrow ring of lamellæ and Haversian systems. In the posterior lateral wall is a group of Haversian systems which forms nearly the whole wall. The lacunæ are long and their canaliculi bushy and straight. The remainder of the bone is composed of laminæ, crossed at various angles by canals and interrupted here and there by very crude Haversian systems of the (Ia) differentiation. The lacunæ are long and narrow.

Type II-III, Ia, C.

LEFT FEMUR OF GAZELLA GRANTI. GRANT'S GAZELLE. NO. 27762, AMER. MUS. NAT. HIST.

PL. 18, FIG. 275. SYN. TAB. VII

Antero-posterior diameter of bone, 19 mm.; lateral, 19.5 mm.

Antero-posterior diameter of medullary canal, 10.5 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—The section is composed of a wide horseshoe band of laminæ embracing the posterior ridge. In the anterior wall they are interrupted by Haversian systems, especially near the circumference. They are long and short and their lacunæ are round and oval with bushy and straight canaliculi. Underneath the laminæ of the outer lateral, the anterior, and inner lateral wall is a crescent of Haversian systems well developed. The posterior ridge is composed mostly of Haversian systems. Internal circumferential lamellæ with narrow lacunæ and straight canaliculi surround the medullary canal.

Type II-III, C.

LEFT FEMUR OF KOBUS ELLIPSIPRYMNOS. WATER BUCK. NO. 27669, AMER. MUS. NAT. HIST.

PL. 18, FIG. 276. SYN. TAB. VII

Antero-posterior diameter of bone, 28 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 18 mm.; lateral, 16 mm.

The medullary canal is full. Medullary index, 70%.

Structure.—Beginning on the outer side of the posterior ridge and extending around the outer and anterior wall is an external band of lamellæ, interrupted by Haversian systems of the (Ia) differentiation and by canals. Their lacunæ are long and their canaliculi are straight. The inner wall of the section is composed of laminæ which are continued around the section to the posterior ridge under the lamellar band of the anterior and outer wall. The laminæ are frequently interrupted by Haversian systems. Their lacunæ are long and their canaliculi are straight. The posterior ridge is composed of Haversian systems which are extended around the outer and anterior wall and border upon the medullary canal. Their lacunæ are long.

Type I-II-III, Ia, C.

RIGHT FEMUR OF ARCTOMYS MONAX. WOODCHUCK OR GROUND HOG. CR. MED. COLL.

PL. 19, FIG. 277. SYN. TAB. VII

Antero-posterior diameter of bone, 6 mm.; lateral, 7 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 4.5 mm.

The medullary canal is full. Medullary index, 74%.

Structure.—Two laminæ with long lacunæ and straight canaliculi, interrupted here and there by Haversian systems of the (Ia) differentiation, surround the section with the exception of the posterior ridge.

The central ring is composed of Haversian systems, irregular in shape and of the (C) differentiation, between which are groups of lamellæ extending in different directions. A wide ring of lamellæ, separated into laminæ, surrounds the medullary canal. The lacunæ are long and the canaliculi are straight.

Type II-III, Ia, C.

RIGHT FEMUR OF CANIS LATRANS. COYOTE. CR. MED. COLL.

PL. 19, FIG. 278. SYN. TAB. VII

Antero-posterior diameter of bone, 12 mm.; lateral, 11.5 mm.

Antero-posterior diameter of medullary canal, 8 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 68%.

Structure.—The section is surrounded by external circumferential lamellæ excepting its posterior ridge and anterior wall. Beginning on the outer lateral side of the posterior ridge the lamellæ separate into laminæ. As they pass around the outer lateral to the anterior wall the laminæ decrease in number until they are reduced to a few lamellæ. The lamellæ then pass around the inner wall as a narrow band.

Their lacunæ and canaliculi are well developed. Underneath the lamellæ and laminæ is a wide ring of well developed Haversian systems, widest in the posterior wall where they form nearly the whole thickness of the posterior ridge. The systems frequently unite by cross canals and have long, narrow lacunæ. The medullary canal is enclosed by a ring of lamellæ. In the lateral wall the lamellæ gradually thicken and separate into several laminæ which form half the thickness of the wall. They are well developed.

Type II-III, C.

RIGHT FEMUR OF CAPRA. GOAT. CR. MED. COLL.

PL. 19, FIG. 279. SYN. TAB. VII

Antero-posterior diameter of bone, 4.5 mm.; lateral, 5 mm.

Antero-posterior diameter of medullary canal, 2.5 mm.; lateral, 3 mm.

The medullary canal is full. Medullary index, 50%.

Structure.—The section is surrounded by a ring of laminæ, divided into short, long, and irregular segments by transverse canals and interrupted by small Haversian systems of the (Ib) differentiation. Underneath this is a wide central ring of laminæ arranged concentrically and obliquely and interrupted frequently by Haversian systems of the (Ib) and (C) differentiations. In the anterior and posterior wall are two crescents of Haversian systems, and in the outer portion of the posterior wall a group of Haversian systems.

A narrow ring of lamellæ surrounds the medullary canal. The lacunæ are generally oval and the canaliculi are straight.

Type II-III, Ib, C.

RIGHT FEMUR OF A BULL DOG (NOT A PURE BLOOD). NO. 292, CR. MED. COLL.

PL. 19, FIG. 279½. SYN. TAB. VII

Antero-posterior diameter of bone, 14.5 mm.; lateral, 12.5 mm.

Antero-posterior diameter of medullary canal, 10.5 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 109%.

Structure.—The section is composed of a horseshoe of laminæ and lamellæ, separated into two bands by a central band of Haversian systems. The laminæ constitute the whole of the inner wall, and as they reach the anterior wall they become lamellæ, which are then separated into external and internal bands by a central band of Haversian systems. The three bands, external lamellar, central Haversian system, and internal lamellar form the outer wall. The internal lamellæ are frequently crossed by radiating canals. The posterior ridge is composed of Haversian systems with comparatively few lacunæ. Their bone substance is in excess of that usually seen. In the anterior wall near the medullary canal are four quite large openings.

Type I-II-III, C.

LEFT FEMUR OF A SHEPHERD DOG (NOT A PURE BLOOD). NO. 201, CR. MED. COLL.

PL. 19, FIG. 280. SYN. TAB. VII

Antero-posterior diameter of bone, 11 mm.; lateral, 10.5 mm.

Antero-posterior diameter of medullary canal, 6.5 mm.; lateral, 5.5 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—The section is surrounded by a horseshoe band of laminæ which constitutes the principal part of the bone. Between the laminæ are canals which widen into circular areas at intervals. The lacunæ are oval and long. The central ring is reduced to a long, narrow crescent of Haversian systems extending around the anterior, outer, and posterior wall. The posterior ridge is almost entirely composed of Haversian systems. The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type II-III, C.

RIGHT FEMUR OF A DOG. NO. 291, CR. MED. COLL.

PL. 19, FIG. 280½. SYN. TAB. VII

Antero-posterior diameter of bone, 16 mm.; lateral, 17 mm.

Antero-posterior diameter of medullary canal, 11 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 68%.

Structure.—The section is composed of a horseshoe band of lamellæ and laminæ, interrupted by Haversian systems of the (Ia) differentiation. In the outer wall the lamellæ are separated into two nearly equal concentric bands by a middle band of Haversian systems. The lamellar bands are frequently crossed by radiating canals and interrupted by crude Haversian canals. The lamellæ on reaching the anterior wall separate into laminæ, which constitute the whole inner wall. Here and there the canals between the laminæ widen into circular openings. The posterior ridge is composed of Haversian systems, between which are short lamellæ with round lacunæ. The internal circumferential lamellæ surround the medullary canal.

Type I-II-III, Ia, C.

FEMUR OF A FOX TERRIER (NOT A PURE BLOOD). NO. 202, CR. MED. COLL.

PL. 19, FIG. 281. SYN. TAB. VII

Antero-posterior diameter of bone, 11 mm.; lateral, 9.5 mm.

Antero-posterior diameter of medullary canal, 6.5 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 59%.

Structure.—The section is surrounded by a wide horseshoe of laminæ which forms three-fourths of the thickness of the wall of the bone. The canals between the laminæ widen at intervals into circular areas. The laminæ are frequently crossed by irregular canals. The lacunæ are oval. The central ring is a narrow crescent and is composed of well developed Haversian systems. The ring reaches the surface of the posterior ridge where it is composed of vascular canals surrounded by concentric lamellæ. Between the canals are long, minute, tendon insertions. The internal circumferential lamellæ form a narrow ring around the medullary canal. Just behind the ring are several large vascular spaces.

Type II-III, C.

RIGHT FEMUR OF A MONGREL DOG (NO CHARACTERISTIC FEATURES). NO. 200, CR. MED. COLL.

PL. 19, FIG. 282. SYN. TAB. VII

Antero-posterior diameter of bone, 12.5 mm.; lateral, 13 mm.

Antero-posterior diameter of medullary canal, 8.5 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 90%.

Structure.—The section is surrounded by a horseshoe band of laminæ and lamellæ. The laminæ form the whole width of the inner wall. They then become fewer in number as they reach the anterior wall, where they are reduced to a narrow lamellar band. The lamellæ then widen and separate into laminæ as the band reaches the posterior ridge. The central ring is reduced to a long, narrow crescent of Haversian systems which nearly encircles the section. The systems reach the surface of the posterior ridge and form nearly the whole width of the posterior wall. They are well developed. The internal circumferential lamellæ do not form an enclosing ring. In the posterior wall they form a narrow band, in the outer wall the band widens into laminæ, and in the anterior outer lateral wall the laminæ form three-fourths of the wall. In the anterior inner lateral wall the lamellæ and laminæ disappear altogether and Haversian systems form the boundary of the medullary canal.

Type II-III, C.

RIGHT FEMUR OF A BULL DOG (NOT A PURE BLOOD). NO. 204, CR. MED. COLL.

PL. 19, FIG. 283. SYN. TAB. VII

Antero-posterior diameter of bone, 13 mm.; lateral, 12 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 6.5 mm.

The medullary canal is full. Medullary index, 41%.

Structure.—The section is surrounded by a wide horseshoe of crude laminæ intermixed with Haversian systems. The shoe is widest in the outer wall where it forms half the width of the wall. In the inner wall the systems are irregular and more numerous than elsewhere. The central ring is composed of Haversian systems. It reaches the surface of the posterior ridge. Between the systems near the posterior surface and extending along the external boundary on either side of the ridge are oblique tendon insertions. The ring is narrowest in the outer wall. The internal circumferential lamellæ enclose the medullary canal. They form a thick band along the inner and anterior walls. The thick band is crossed frequently by cross canals.

Type II-III, C.

RIGHT FEMUR OF A COLLIE DOG (NOT A PURE BLOOD). NO. 203, CR. MED. COLL.

PL. 19, FIG. 284. SYN. TAB. VII

Antero-posterior diameter of bone, 13.5 mm.; lateral, 13 mm.

Antero-posterior diameter of medullary canal, 8 mm.; lateral, 7.5 mm.

The medullary canal is full. Medullary index, 50%.

Structure.—The section is enclosed by a horseshoe of lamellæ, interrupted by small Haversian systems and partially separated by canals. The lamellæ form nearly half of the width of the wall of the bone. The central ring is composed of well developed Haversian systems which constitute the entire posterior ridge with the exception of the internal lamellæ. The internal circumferential lamellæ form a ring of varying widths surrounding the medullary canal.

Type I-II-III, C.

RIGHT FEMUR OF A SPANIEL (NOT A PURE BLOOD). NO. 205, CR. MED. COLL.

PL. 19, FIG. 285. SYN. TAB. VII

Antero-posterior diameter of bone, 13 mm.; lateral, 13.5 mm.

Antero-posterior diameter of medullary canal, 8.5 mm.; lateral, 8.5 mm.

The medullary canal is full. Medullary index, 70%.

Structure.—The section is surrounded by a narrow horseshoe of lamellæ, widest in the inner wall. The central ring forms the greater portion of the width of the wall. It reaches the surface of the posterior ridge and constitutes nearly all of the posterior wall. The ring is composed of well developed Haversian systems. The internal circumferential lamellæ form a ring of lamellæ and laminæ extending in various directions.

Type II-III, C.

The femora of ten dogs were examined and no two of them showed the same structure. They ranged from a second to a second and third combination. In the combinations the proportions of the units varied greatly.

LEFT FEMUR OF LEPUS CUNICULUS. RABBIT. CR. MED. COLL.

PL. 19, FIG. 286. SYN. TAB. VII

Antero-posterior diameter of bone, 5.5 mm.; lateral, 7.5 mm.

Antero-posterior diameter of medullary canal, 3.5 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 74%.

Structure.—Around the bone is a ring of lamellæ of varying thicknesses. As a whole, it is narrow, and, in the posterior wall, merges into oblique laminæ which join the internal circumferential lamellæ. The lacunæ are long and narrow and the canaliculi are long and branching.

There is a central ring of incomplete Haversian systems and short, irregular laminæ occupying the anterior and inner wall. In the posterior wall this ring is interrupted by oblique, well developed Haversian systems and laminæ extending from the internal to the external circumferential lamellæ. In the outer wall there are wide, oblique canals separating irregular laminæ extending from the internal to the external lamellæ and interdigitating with extensions from the periosteum. These two oblique arrangements enclose a small crescent of irregular systems and lamellæ. The lacunæ are oval or long and the canaliculi are bushy.

Internal circumferential lamellæ of varying thickness and well developed surround the medullary canal. In the inner and posterior wall it merges into oblique, wide laminæ, separated by an oblique row of complete Haversian systems. To the outer side of this row of systems are three or four wide, oblique laminæ which appear to be extensions of the internal lamellæ.

Type I-II-III, C.

RIGHT FEMUR OF PROCYON LOTOR. RACCOON

PL. 20, FIG. 287. SYN. TAB. VII

Antero-posterior diameter of bone, 9 mm.; lateral, 10 mm.

Antero-posterior diameter of medullary canal, 6.5 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 100%.

Structure.—The section is surrounded by external circumferential lamellæ. In the anterior and posterior inner wall the ring is thick and interrupted by Haversian systems of the (Ia) differentiation. The lacunæ are long and narrow and the canaliculi are long.

The central ring is composed of irregularly shaped Haversian systems well developed. It gradually increases in thickness in the inner wall until it reaches about the middle, where it forms two-thirds of the width of the wall. From this point it continues to increase to the middle of the anterior wall, where it forms four-fifths of the bone. The systems are strongly developed, their lacunæ are long and narrow, and their canaliculi are long and branching. Between the systems are short lamellæ. The Haversian canals frequently unite.

A ring of internal circumferential laminæ of varying thickness surrounds the medullary canal. In the inner wall and extending around the posterior region are short, oblique laminæ, forming, in some places, nearly one-half of the thickness of the bone. In the outer wall two or three laminæ form the medullary boundary. The lacunæ are long and narrow and the canaliculi are long and branching.

Type I-II-III, Ia, C.

OS PENIS OF THE RACCOON

Pl. 20, Fig. 288. Syn. Tab. VII

The os penis is introduced here because of its relation to the general bone structure of the animal and its relation of structure to function.

The antero-posterior diameter of the bone is 4 mm.; lateral, 4 mm.

The antero-posterior diameter of the central canal is 0.8 mm.; lateral, 0.8 mm.

The canal is very irregular in shape. The bone is of medium hardness.

The medullary canal is full. Medullary index, 4%.

Structure.—External circumferential lamellæ, rather incompletely developed, surround the bone. They are not equally distinct in all parts. In some places they are fairly well developed, while in others they are indistinct and interrupted by small, incomplete Haversian systems. The lacunæ are large, few in number, oval in shape, and have branching canaliculi.

A wide ring of large and small Haversian systems constitutes the central ring. The large systems occupy the inner portion of the ring, the small ones the outer portion. They are all fairly well developed. Their Haversian canals frequently communicate with each other; their cross-sections are circular; their lacunæ are few, long, and narrow; their canaliculi are long and branching; and their lamellæ are not clearly defined. Here and there short inter-Haversian lamellæ appear.

Internal circumferential lamellæ form a very irregular boundary of the medullary canal. The lacunæ are long and their canaliculi are very numerous and branching.

Type I-III, C.

FEMUR OF CANIS LUPUS. WOLF

PL. 20, FIG. 289. SYN. TAB. VII

Antero-posterior diameter of bone, 16.5 mm.; lateral, 7 mm.

Antero-posterior diameter of medullary canal, 10 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 77%.

Structure.—Beginning on both sides of the posterior ridge and extending around the two lateral portions of the wall of the bone are two wide bands of laminæ, interrupted by Haversian systems of the (Ia) and (C) differentiations. As the bands reach the anterior wall the laminæ are reduced to a narrow rim of external circumferential lamellæ. Beginning on both sides of the posterior wall, directly underneath the internal circumferential lamellæ and extending around the anterior wall, is a central crescent of well developed Haversian systems. Bordering the medullary surface of the anterior wall is an area of laminæ. The posterior ridge is composed of well developed Haversian systems. A narrow lamina surrounds the medullary canal.

Type II-III, Ia, C.

RIGHT FEMUR OF FELIS LEO. LION. AMER. MUS. NAT. HIST.

PL. 20, FIG. 290. SYN. TAB. VII

Antero-posterior diameter of bone, 26 mm.; lateral, 25.5 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 11.5 mm.

The medullary canal is full. Medullary index, 28%.

Structure.—The section is partly surrounded by a band of lamellæ and crude laminæ, interrupted by Haversian systems of the (Ia) and (C) differentiations. The band is broken at the posterior ridge and outer antero-lateral wall by Haversian systems of the central ring.

The central ring occupies the posterior wall and the remainder of the section excepting that part immediately surrounding the medullary canal. It is composed of well developed Haversian systems, which are separated into two nearly equal portions by a narrow laminar extension of the wide band of the inner lateral wall.

The internal circumferential lamellæ form a narrow ring around the medullary canal. Immediately behind this, in the outer anterior wall, are a number of spaces.

Type I-II-III, Ia, C.

FEMUR OF CANIS. SMALL GREY FOX. CR. MED. COLL.

PL. 20, FIG. 291. SYN. TAB. VII

Antero-posterior diameter of bone, 8 mm.; lateral, 9 mm.

Antero-posterior diameter of medullary canal, 5 mm.; lateral, 6.5 mm.

The medullary canal is full. Medullary index, 80%.

Structure.—A ring of external circumferential lamellæ and laminæ, interrupted by Haversian systems of the (Ia) differentiation, surrounds the bone. In the outer wall the lamellar ring is distinct, but in the inner wall it widens and separates into laminæ which occupy the whole thickness of the wall. The laminæ are short and are separated and crossed by intercommunicating canals. On the inner lateral side of the posterior wall is a ridge and the laminæ from the inner wall reach the surface at this point and appear to interdigitate with inward extensions from the periosteum. The lacunæ are long and narrow; the canaliculi are long and branching.

The central ring is composed of a wide crescent of well developed Haversian systems, the horns of which begin a short distance apart in the inner wall, while the widest part of the body occupies the outer wall. The systems are small and large, regular and irregular in shape. Their lamellæ are well defined; their lacunæ are long and narrow; and their canaliculi are branching. Their Haversian canals frequently communicate.

Around a portion of the medullary canal is a border of Haversian systems. The internal circumferential lamellæ form an incomplete ring around the medullary canal.

Type I-II-III, Ia, C.

LEFT FEMUR OF TAXIDEA AMERICANA. AMERICAN BADGER. AMER. MUS. NAT. HIST.

PL. 20, FIG. 292. SYN. TAB. VII

Antero-posterior diameter of bone, 7 mm.; lateral, 8 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 4 mm.

The medullary canal is full. Medullary index, 40%.

Structure.—The section is surrounded in the anterior and lateral wall by external circumferential lamellæ. In the posterior wall the lamellæ are arranged obliquely. Under the lamellæ is a narrow crescent of small, well developed Haversian systems. Under the ring of systems is a wide ring of laminæ which in the posterior wall are arranged obliquely from the medullary canal. The canals between the laminæ are wide and branching. The lacunæ are oval and long.

Type I-II-III, C.

RIGHT FEMUR OF MELURSUS LABIATUS. SLOTH BEAR. NO. 22720, AMER. MUS. NAT. HIST.

PL. 20, FIG. 293. SYN. TAB. VII

Antero-posterior diameter of bone, 24 mm.; lateral, 24 mm.

Antero-posterior diameter of medullary canal, 10 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 21%.

Structure.—A horseshoe band of lamellæ, laminæ, and Haversian systems of the (Ia) differentiation embraces the posterior ridge. The band is widest in the inner wall, where it is composed of lamellæ and laminæ alternating with Haversian systems. The lacunæ are oval and long.

The central ring is composed of lamellæ, laminæ, and Haversian systems intermixed and alternating with each other. The systems are well developed. The posterior ridge is composed of Haversian systems and lamellæ having a direction from the external to the medullary surface.

The internal circumferential lamellæ form a narrow ring around the medullary canal. The lacunæ are long.

The bone is peculiar in the mixture of its units.

Type I-II-III, Ia, C.

LEFT FEMUR OF CANIS AUREUS. JACKAL. NO. 163293, U. S. NAT MUS.

PL. 20, FIG. 294. SYN. TAB. VII

Antero-posterior diameter of bone, 10 mm.; lateral, 8.5 mm.

Antero-posterior diameter of medullary canal, 6.5 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 85%.

Structure.—An irregular horseshoe of lamellæ and laminæ surrounds the section. On the outer side of the posterior ridge the lamellæ are wide, as they extend around the outer lateral wall they become very narrow, then widen again in the anterior wall to more than half the width, and as they pass around the inner wall they separate into laminæ, diminish in width, and terminate in the inner posterior region. The lamellæ are interrupted by Haversian systems of the (Ia) differentiation. They are frequently crossed by canals. Underneath the lamellæ and laminæ is an irregularly shaped central ring of Haversian systems. It forms the whole width of the posterior and adjacent inner wall. The systems are large and small and well developed. In the outer wall they are elongated in cross-section, especially in the anterior region. A narrow ring of internal circumferential lamellæ surrounds the medullary canal.

Type I-II-III, Ia, C.

RIGHT FEMUR OF DIDELPHYS VIRGINIANA. OPOSSUM. CR. MED. COLL.

PL. 20, FIG. 295. SYN. TAB. VII

Antero-posterior diameter of bone, 7 mm.; lateral, 8.5 mm.

Antero-posterior diameter of medullary canal, 3.5 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—The bone presents a rudimentary appearance. It is composed of two wide external lamellar bands of incomplete formation, separated by a very narrow band of imperfectly developed Haversian systems, the whole occupying two-thirds of the posterior, outer, and anterior wall. The lamellar bands are composed of bone substance with large, oval lacunæ and extensive, bushy canaliculi forming an intricate network. At short intervals radiating canals appear, giving a bush-like appearance to the band. Just internal to this lamellar band is a narrow crescent of very incomplete Haversian systems occupying the anterior, outer, and posterior wall. The systems are of the (Ib) differentiation. Around the medullary canal of the anterior, outer, and posterior wall, internal circumferential lamellæ are well developed, reaching their greatest thickness in the outer wall. Their lacunæ are long and narrow and their canaliculi are long, straight, and branching.

The inner wall of the bone is extended in the form of a heavy ridge. It is composed of bone substance with heavy, oblique canals, from which are sent off dense networks of large canaliculi. This peculiar arrangement forms the external half of the ridge. The internal half is composed of incomplete Haversian systems, arranged in oblique rows, converging to a central point in the middle of the ridge. No internal circumferential lamellæ are found in this region.

Type I-III, Ib.

LEFT FEMUR OF MANIS. ANT-EATER. NO. 8351, U. S. NAT. MUS.

PL. 20, FIG. 296. SYN. TAB. VII

Antero-posterior diameter of bone, 9 mm.; lateral, 12.5 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 5.5 mm.

The medullary canal is full. Medullary index, 24%.

Structure.—The three structural divisions appear in a somewhat modified form. A thick, incomplete ring of crude circumferential laminæ surrounds the section, excepting the posterior ridge. The laminæ are wide and composed of lamellæ having round and oval lacunæ with bushy canaliculi. They are separated by irregularly shaped canals which appear fragmentary in the section. In some situations the canals are branching and arranged in plexus form. The laminæ are frequently interrupted by Haversian canals of the (Ia) differentiation.

The central ring is composed of Haversian systems of the (Ib) differentiation. Their lacunæ are generally oval or round, in a few places long and narrow, and are at some distance from the Haversian canals. Their canaliculi are long. The rings break through the external circumferential laminæ at the inner ridge and form the whole width of the ridge, from the internal circumferential lamellæ to the external surface. The internal circumferential lamellæ of the different widths surround the medullary canal and in some places form cancellous structure. Their lacunæ are long, narrow, and well developed.

Type II-III, Ia, Ib.

RIGHT FEMUR OF HAPLODONTIA OLYMPICA. SEWELLEL, MOUNTAIN BEAVER, OR FARMER

PL. 20, FIG. 297. SYN. TAB. VII

Antero-posterior diameter of bone, 5.5 mm.; lateral, 4 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 1.5 mm.

The medullary canal is full. Medullary index, 26%.

Structure.—The section is composed of a confusing mixture of lamellæ, laminæ, and Haversian systems of various differentiations. A narrow ring of lamellæ and crude Haversian systems surrounds the bone. The central ring is composed of crude Haversian systems, following no definite plan of arrangement and representing no definite state of development. The ring is crossed obliquely by a few laminæ and separated into two parts by concentric lamellæ. The internal circumferential lamellæ are incomplete.

Type I-II-III, Ia, Ib.

LEFT FEMUR OF ERETHIZON. PORCUPINE. CR. MED. COLL.

PL. 20, FIG. 298. SYN. TAB. VII

Antero-posterior diameter of bone, 9.5 mm.; lateral, 7.5 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 12%.

Structure.—With the exception of the posterior wall the section is surrounded by a narrow band of external circumferential lamellæ. The posterior wall is composed of crude Haversian systems and inter-Haversian bone substance with oval lacunæ and bushy canaliculi.

The central ring is composed of Haversian systems and inter-Haversian bone substance with oval lacunæ and bushy canaliculi.

Internal circumferential lamellæ, crossed by many radiating canals and interrupted by Haversian systems of the (Ia) and (Ib) differentiation, surround the medullary canal.

Type I-III, Ia, Ib, C.

XI. MAN

One hundred and thirty-nine femora were examined.

General Character of the Femur

The femur of man presents a variety of shapes.

The medullary canals are generally full of cancellous bone, the meshes of which are filled with marrow. The medullary surfaces are almost always rough, but in some round sections the surfaces are smooth and cancellous bone is absent.

The average medullary index of the adult is 38.6%. Comparing the average index of man with that of other mammals, which is 63.3%, it will be noticed that the medullary canal is proportionately smaller and the wall of the bone thicker in man than in other mammals, or in bipeds than in quadrupeds.

The following types and combinations of types are found: the third, first and third, second and third, and first, second, and third. The third type occurs in the (Ia), (Ib), and (C) forms of differentiation. The pure third type bone without senile changes is rather infrequent. The human series consists of the fetal, infantile, adolescent, and adult femora. The fetal series includes the white and black races; the infantile, the yellow-brown, ancient Egyptian, and modern white races; the adolescent, the yellow-brown, ancient Egyptian, and white races; and the adult, all races.

Fetal Human Femora

Seven femora were examined.

In the very young fetus of two to three months, basic bone substance is present and is marked off into regular areas by crude, branching canals. As fetal life advances the canals become less branching and more concentric. Gradually the basic bone becomes lamellated and then develops into the second type and remains so until birth. Throughout childhood and youth the laminæ tend to disappear and to be replaced by Haversian systems, until the bone development is completed.

In the formation of human fetal femora the following plan was observed. A horseshoe-shaped band of lamellæ or laminæ with oval lacunæ and bushy canaliculi is formed around the medullary canal, with the exception of the posterior ridge which appears to have an independent formation at a later date. As the bone develops the ridge fuses with the lateral wall.

RIGHT FEMUR OF A WHITE FETUS, TWO AND ONE-HALF MONTHS OLD

Pl. 21, Fig. 299. Syn. Tab. VIII

Antero-posterior diameter of bone, 1.8.; lateral, 1.5 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.4 mm.

The medullary canal is full. Medullary index, 8%.

Structure.—The section is composed of two concentric rings of bone substance, external and internal. The external—much the wider—forms most of the wall of the bone, and is composed of channelled bone substance with round lacunæ and relatively few canaliculi. In some portions the elongated meshes assume the character of laminar formation.

The internal circumferential lamellæ with long lacunæ and bushy canaliculi form a narrow ring around the medullary canal.

Type I.

RIGHT FEMUR OF A WHITE FETUS, THREE AND ONE-HALF MONTHS OLD. NO. 89, CR. MED. COLL.

PL. 21. FIG. 300. SYN. TAB. VIII

Antero-posterior diameter of bone, 2.5 mm.; lateral, 2 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 5%.

Structure.—The anterior wall is much thinner than the posterior. The section is composed of bone substance within which are irregularly shaped canals. Between the canals the bone substance, with oval lacunæ and short, bushy canaliculi, is arranged concentrically around the medullary canal. In some situations the canals with their adjacent lacunæ have the formations of Haversian systems of the (Ia) differentiation. The posterior ridge forms the whole posterior wall, and is composed of bone substance with wide canals having a direction from the external to the medullary surface and presenting the appearance of long canals divided into shorter ones until crude Haversian canals are formed. The bone substance has oval lacunæ and bushy canaliculi. The medullary canal is small and concentrically situated.

Type II-III, Ia.

RIGHT FEMUR OF A WHITE FETUS, FOUR MONTHS. NO. 90, CR. MED. COLL.

PL. 21, FIG. 301. SYN. TAB. VIII

Antero-posterior diameter of bone, 3.5 mm.; lateral, 2.5 mm.

Antero-posterior diameter of medullary canal, 0.6 mm.; lateral, 0.5 mm.

The medullary canal is full. Medullary index, 3%.

Structure.—The anterior wall is much thinner than the posterior. The section is composed of bone substance with oval lacunæ and bushy canaliculi, interrupted by wide, irregular canals bent around the medullary canal in the shape of a horseshoe. A few crude, elongated Haversian systems are found in the posterior wall. The posterior ridge is composed of a few undeveloped Haversian systems of the (Ib) differentiation and inter-Haversian bone substance with wide canals, extending from the external to the medullary surface. The

Haversian systems of the ridge are somewhat better developed than in the three months' fetus.

Type II-III, Ib.

RIGHT FEMUR OF A WHITE FETUS, FIVE TO SEVEN MONTHS. NO. 248045, U. S. NAT. MUS.

PL. 21, FIG. 302. SYN. TAB. VIII

Antero-posterior diameter of bone, 3.5 mm.; lateral, 3 mm.

Antero-posterior diameter of medullary canal, 0.5 mm.; lateral, 0.5 mm.

The medullary canal is very small and occupies a very eccentric position. Medullary index, 2%.

Structure.—The section is composed of a wide horseshoe band of long and short laminæ arranged around the medullary canal. The toe forms the very narrow anterior wall and the heel embraces the very wide posterior ridge. The laminæ have central canals and are composed of lamellæ with oval lacunæ and bushy canaliculi. They widen and shorten as they approach the posterior ridge and on either side of it they have become Haversian systems of the (Ib) differentiation. The posterior ridge is composed of long and short spaces surrounded by lamellæ extending from the external to the medullary surface. The section exhibits the early formation of laminæ, the horseshoe arrangement, the formation of Haversian systems, and the later formation of the posterior ridge. Two laminæ with round and oval lacunæ and short bushy canaliculi surround the medullary canal.

Type II-III, Ib.

RIGHT FEMUR OF A WHITE FETUS, EIGHT TO NINE MONTHS. NO. 228842, U. S. NAT. MUS.

PL. 21, FIG. 303. SYN. TAB. VIII

Antero-posterior diameter of bone, 4.5 mm.; lateral, 5 mm.

Antero-posterior diameter of medullary canal, 1 mm.; lateral, 1 mm.

The medullary canal is irregular in shape and is situated in the anterior half of the microsection. Medullary index, 4%.

Structure.—Around the outside of the section—posterior ridge excepted—is a narrow band of incompletely developed lamellæ with oval lacunæ and short, bushy canaliculi. The remainder of the anterior and lateral wall is composed of a wide, horseshoe-shaped band enclosing the medullary canal. It is composed of long laminæ with central canals gradually shortening and widening as they pass around the lateral wall until they are transformed into oval Haversian systems close to the posterior ridge. The posterior ridge is composed of elongated, crude Haversian systems of the (Ib) differentiation, and short laminæ extending from the external to the medullary surface and at right angles to the laminæ of the lateral wall. In the center of the ridge is a narrow space where the wall of the bone has united or is about to unite. Many large oval lacunæ are found in the bone substance between the systems. The bone shows the formation of Haversian systems, the filling of the posterior ridge by laminæ at right angles to the lateral walls, and the line of union as the walls fuse together in the posterior ridge. A wide band of lamellæ with oval lacunæ and bushy canaliculi surrounds the medullary canal.

Type II-III, Ib.

RIGHT FEMUR OF AMERICAN NEGRO FETUS, NINE MONTHS. NO. 228801, U. S. NAT. MUS.

PL. 21, FIG. 304. SYN. TAB. VIII

Antero-posterior diameter of bone, 4.5 mm.; lateral, 5.5 mm.

Antero-posterior diameter of medullary canal, 1.5 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 15%.

Structure.—The anterior wall is composed of a few external circumferential lamellæ, which, as they leave the mid-line, soon spread out and enclose elongated, crude Haversian systems of the (Ib) differentiation. The systems, which appear to be laminæ crudely bent around and along wide, short canals, assume a concentric arrangement and enclose the medullary canal in the form of a horseshoe. The posterior ridge is then formed and fuses with the lateral wall. The lacunæ are oval; the canaliculi are comparatively few and bushy. In the mid-line of the anterior wall the external circumferential lamellæ are distinctly separated from the crude Haversian systems, but this line of separation soon becomes indistinct. The Haversian systems vary in shape and completeness in the different portions of the wall. In the anterior portion they are round or oval, especially just beneath the external circumferential lamellæ where they are most complete. The Haversian canals are relatively wide. The lacunæ of the systems form single concentric rings around the Haversian canals and at some distance from them. They are oval with short, bushy canaliculi. The Haversian systems gradually elongate and become extremely elliptical as they approach the posterior ridge. Here the Haversian canals are long, wide, and generally parallel. They occupy nearly the whole thickness of the posterior wall and extend from the external to the medullary surface. The Haversian canals of the lateral wall are wide, irregular, and long, but are generally parallel with the external surface of the bone. The lacunæ are oval, few, and confined to a single concentric row situated at some distance from the canal. The posterior ridge appears to be formed at a later date than the anterior and lateral walls. The internal circumferential lamellæ with long lacunæ and straight canaliculi are present in the anterior wall, but not elsewhere.

Type II-III, Ib.

RIGHT FEMUR OF CRANIORRHACHISCHISIS—WHITE FETUS. NO. 91, CR. MED. COLL.

PL. 21, FIG. 305. SYN. TAB. VIII

Antero-posterior diameter of bone, 6 mm.; lateral, 6 mm.

Antero-posterior diameter of medullary canal, 3 mm.; lateral, 2.5 mm.

The medullary canal is full. Medullary index, 26%.

Structure.—The bone has no distinct divisions. The anterior wall is thinnest; the posterior is thickest. The bone is composed of a wide horseshoe of irregular, concentric laminæ with wide canals surrounding the medullary canal. The laminæ of the posterior ridge with their wide canals shorten, widen, and become crude, elongated Haversian systems, running from the external to the medullary surface and at right angles to the laminæ of the lateral wall. The lacunæ are oval and the canaliculi are bushy. The femur is larger than that of the normal fetus of the same age.

Type II-III, Ib.

In the development of human fetal femora some of the Haversian systems appear to be produced by the aberrant method of formation; that is, by the transformation of laminæ into Haversian systems.

XII. MAN—BLACK RACE

General Character of the Femur

The bones vary in shape. The medullary canals are full and cancellous bone is prominent. The medullary surfaces are very much corrugated and irregular in character. The medullary index varies from 17% to 92%, with an average of 41.9%. The type of structure ranges from a first and third to a complete third, and the majority are type combinations rather than single types. The first and third and first, second and third are the most frequent combinations. Senile changes are found in many femora. The bone units are incompletely and completely differentiated.

Detailed Examination

LEFT FEMUR OF NEGRO. NO. 228481, U. S. NAT. MUS.

PL. 21, FIG. 306. SYN. TAB. VIII

Antero-posterior diameter of bone, 29 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—The external circumferential lamellæ, in fragments, surround the bone. The lacunæ are long and narrow and the canaliculi are straight.

The central ring, forming nearly the whole thickness of the wall of the bone, is composed of well developed Haversian systems with little or no inter-Haversian lamellæ. The horseshoe areas have been displaced entirely by well developed Haversian systems. The internal circumferential lamellæ with long lacunæ and straight canaliculi surround the medullary canal.

Type III, C.

The degree of development of a human femur is proportionate to the degree of displacement of its lamellæ or laminæ by Haversian systems.

FEMUR OF WHITE AND NEGRO MIXED, AT LEAST ONE-HALF WHITE. NO. 247368, U. S. NAT. MUS.

PL. 21, FIG. 307. SYN. TAB. VIII

Antero-posterior diameter of bone, 22 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 12 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 30%.

Structure.—The external circumferential lamellæ, in fragments, surround the bone. Their lacunæ and canaliculi are well developed. There is little evidence of the horseshoe band of lamellæ. The central ring is composed of Haversian systems and forms nearly the whole width of the wall. The systems are of unequal sizes, some are small and others are large relatively, but generally they are rather small. There is also a corresponding variation in the diameters of the Haversian canals. The lacunæ and canaliculi of the Haversian systems are of the fully developed variety. Many Haversian systems are senile.

The internal circumferential lamellæ with long lacunæ and straight canaliculi surround the medullary canal.

Type III, C, senile.

LEFT FEMUR OF A NEGRO. NO. 3, MED. DEPT. TULANE UNIV.

PL. 21, FIG. 308. SYN. TAB. VIII

Antero-posterior diameter of bone, 30 mm.; lateral, 24 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 41%.

Structure.—External circumferential lamellæ with long lacunæ and straight canaliculi are fragmentary. The central ring forms most of the bone and is composed of Haversian systems of the (C) differentiation. Many show senile changes. A narrow ring of internal circumferential lamellæ surrounds the medullary canal.

Type III, C, senile.

LEFT FEMUR OF A NEGRO. NO. 87, MED. DEPT. TULANE UNIV.

PL. 22, FIG. 309. SYN. TAB. VIII

Antero-posterior diameter of bone, 27.5 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 17 mm.

The medullary canal is full. Medullary index, 54%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring is composed of large, small, and irregular Haversian systems, which show marked senile changes. The internal lamellæ form a fragmentary ring around the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF A NEGRO. NO. 7, MED. DEPT. TULANE UNIV.

PL. 22, FIG. 310. SYN. TAB. VIII

Antero-posterior diameter of bone, 27 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 19 mm.; lateral, 18 mm.

The medullary canal is full. Medullary index, 74%.

Structure.—The external lamellæ are fragmentary. The central ring is composed of Haversian systems with few senile changes. The internal lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

LEFT FEMUR OF A NEGRO. NO. 4, MED. DEPT. TULANE UNIV.

PL. 22, FIG. 311. SYN. TAB. VIII

Antero-posterior diameter of bone, 30 mm.; lateral, 23 mm.

Antero-posterior diameter of medullary canal, 21 mm.; lateral, 13 mm.

The medullary canal is full. Medullary index, 65%.

Structure.—The external circumferential lamellæ form a narrow enclosing ring, excepting in the posterior ridge where it is absent. The central ring forms most of the section and is composed of regular, well developed Haversian systems, excepting in the inner wall where the systems are much elongated.

The internal circumferential lamellæ are fragmentary.

Type III, C.

LEFT FEMUR OF A NEGRO. NO. 84, MED. DEPT. TULANE UNIV.

PL. 22, FIG. 312. SYN. TAB. VIII

Antero-posterior diameter of bone, 24 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 13 mm.

The medullary canal is full. Medullary index, 48%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring is composed of well developed Haversian systems. A narrow ring of internal circumferential lamellæ surrounds the medullary canal.

Type III, C.

LEFT FEMUR OF A NEGRO. NO. 10, MED. DEPT. TULANE UNIV.

PL. 22, FIG. 313. SYN. TAB. VIII

Antero-posterior diameter of bone, 26 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—The section is composed of a wide background of the lamellar horseshoe occupying the lateral wall. The lamellæ are frequently interrupted by Haversian systems of the (C) differentiation. In the anterior wall the lamellæ are replaced by Haversian systems.

The remainder of the section is composed of well developed Haversian systems. Cancellous bone surrounds the medullary canal.

Type I-III, C.

RIGHT FEMUR OF A FEMALE NEGRO. AGE 40. NO. 123, MED. DEPT. TULANE UNIV.

PL. 22, FIG. 314. SYN. TAB. VIII

Antero-posterior diameter of bone, 28 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 25%.

Structure.—The external circumferential lamellæ appear only in fragments. The central ring, which constitutes most of the bone, is composed of Haversian systems, many of which are senile. The internal circumferential lamellæ form a narrow ring around the medullary canal. The lacunæ of all units are oval and long and the canaliculi are straight.

Type III, C, senile.

LEFT FEMUR OF A NEGRO. AGE 40. NO. 79, MED. DEPT. TULANE UNIV.

PL. 22, FIG. 315. SYN. TAB. VIII

Antero-posterior diameter of bone, 30.5 mm.; lateral, 26.5 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 46%.

Structure.—The external circumferential lamellæ appear only in fragments. The central ring forms most of the section and is composed of Haversian systems. Around the medullary region nearly half of the wall of the bone is composed of Haversian systems in an extremely senile condition. The systems of the peripheral portion are in pretty good condition, although senile changes are present to some extent.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

LEFT FEMUR OF A NEGRO. NO. 224714, U. S. NAT. MUS.

PL. 22, FIG. 316. SYN. TAB. VIII

Antero-posterior diameter of bone, 34 mm.; lateral, 36 mm.

Antero-posterior diameter of medullary canal, 21 mm.; lateral, 21 mm.

The medullary canal is full. Medullary index, 56%.

Structure.—Beginning on the inner side of the posterior ridge and extending around the lateral to the anterior wall is one-half of the lamellar horseshoe described in the foregoing femora. The lamellar shoe is studded with many Haversian systems. The central ring is narrow and composed of Haversian systems, many of which are senile. The posterior ridge and adjoining outer wall are composed entirely of Haversian systems. Internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-III, C, senile.

LEFT FEMUR OF A NEGRO. NO. 11, MED. DEPT. TULANE UNIV.

PL. 22, FIG. 317. SYN. TAB. VIII

Antero-posterior diameter of bone, 32 mm.; lateral, 26.5 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 22%.

Structure.—The remains of the lamellar horseshoe band are evident. It is narrow in the outer posterior, widens to one-third the width of the anterior, and extends along the inner wall as a wide band. The band is interrupted by Haversian systems in the lateral wall and by Haversian canals of the (Ia) differentiation in the anterior wall. The central ring is composed of well developed Haversian systems. The internal lamellæ form a wide ring around the medullary canal.

Type I-III, Ia, C.

RIGHT FEMUR OF A NEGRO. NO. 2, MED. DEPT. TULANE UNIV.

PL. 23, FIG. 318. SYN. TAB. VIII

Antero-posterior diameter of bone, 30 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 36%.

Structure.—The external circumferential lamellæ are fragmentary. Beginning on the outer side of the posterior ridge and extending around the external half of the outer wall is a wide band of alternating laminæ and Haversian systems. Underneath the band is a central ring of Haversian systems. The anterior, inner, and posterior wall is composed almost entirely of Haversian systems. The internal circumferential lamellæ form a narrow, enclosing ring around the medullary canal.

Type I-II-III, C.

LEFT FEMUR OF A NEGRO. NO 56, MED. DEPT. TULANE UNIV.

PL. 23, FIG. 319. SYN. TAB. VIII

Antero-posterior diameter of bone, 27.5 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 43%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring is composed of a wide band of lamellæ with Haversian systems in the outer and anterior wall and of Haversian systems with some inter-Haversian lamellæ in the inner and posterior wall. The systems are well developed but senile to a great extent. The internal circumferential lamellæ are fragmentary.

Type I-III, C, senile.

LEFT FEMUR OF A NEGRESS. NO. 220, CR. MED. COLL.

PL. 23, FIG. 320. SYN. TAB. VIII

Antero-posterior diameter of bone, 30 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 18 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 50%.

Structure.—A wide circumferential horseshoe band of lamellæ forms the background of the section. It is narrowest in the inner, forms two-thirds of the anterior, and over half of the outer wall. In these situations the lamellæ are to some extent displaced by Haversian systems of the (Ia) and (C) differentiations. The central ring is narrow and is composed of Haversian systems, many of which are senile. There are relatively few cross canals. The internal circumferential lamellæ form a narrow ring which becomes cancellous.

Type I-III, Ia, C, senile.

RIGHT AMPUTATED FEMUR OF A NEGRESS. NO. 220, CR. MED. COLL.

PL. 23, FIG. 321. SYN. TAB. VIII

The femur is amputated at lower third.

Antero-posterior diameter of bone, 30 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 24 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 92%.

Structure.—A wide circumferential horseshoe of lamellæ surrounds the section. It gradually increases in width in the inner and outer, and constitutes nearly the whole of the anterior wall. It is interrupted by Haversian systems of the (Ia) and (C) differentiations. The central ring is composed of Haversian systems of varying sizes. The communicating canals between the systems are few. There seems to be great variation in the different femora in this respect, and their variation affords a possible explanation of senile changes in bone. Near the medullary canal the senility is marked. The Haversian systems here are practically gone. The wall of the bone, including the posterior ridge, is very thin. The internal circumferential lamellæ are fragmentary. The senile changes are much more pronounced than in the left femur and may be the result of disuse.

Type I-III, Ia, C, senile.

LEFT FEMUR OF A NEGRESS. AGE 14. NO. 226, CR. MED. COLL.

PL. 23, FIG. 322. SYN. TAB. VIII

The mother is white and the father is not a pure black. The child died from the effects of carbolic acid taken for suicidal purposes. The upper third of the femur has a very small medullary canal.

Antero-posterior diameter of bone, 24 mm.; lateral, 18 mm.

Antero-posterior diameter of medullary canal, 12 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 34%.

Structure.—The posterior ridge is thick and composed of irregularly shaped Haversian systems, separated in the circumferential portion by bone substance with round and oval lacunæ and bushy canaliculi. Numerous canals surrounded by clear areas appear. The external circumferential lamellæ form an enclosing ring. The central ring is composed of Haversian systems, which are oval and round in cross-section and separated in places by short laminæ. Their lacunæ are generally oval; otherwise the systems are fairly well developed. The internal circumferential lamellæ are fragmentary, excepting in the inner wall where they form a wide crescent. The bone is not quite complete.

Type I-III, C.

FEMUR OF A NEGRO. NO. 1, MED. DEPT. TULANE UNIV.

PL. 23, FIG. 323. SYN. TAB. VIII

Antero-posterior diameter of bone, 23 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 11 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 24%.

Structure.—Beginning on both sides of the posterior ridge and extending around the section is a horseshoe of lamellæ, laminæ, and Haversian systems of the (Ia) and (C) differentiations. The shoe is crossed by frequent canals. Under the horseshoe is a middle ring of well developed Haversian systems which reaches the external surface of the posterior ridge.

Internal circumferential lamellæ form a narrow ring around the medullary canal. The section is nearly half lamellæ.

Type I-II-III, Ia, C.

RIGHT FEMUR OF A KAFFIR NEGRO. NO. 263196, U. S. NAT. MUS.

PL. 23, FIG. 324. SYN. TAB. VIII

Antero-posterior diameter of bone, 27 mm.; lateral, 23 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 11.5 mm.

The medullary canal is partly surrounded by cancellous bone and is full. Medullary index, 32%.

Structure.—The external circumferential lamellæ are fragmentary. Beginning on the outer side of the posterior ridge and extending around the outer lateral wall is a wide external band of elongated Haversian systems in a background of lamellæ. This band, one-half the width of the wall, bends inward toward the internal circumferential lamellæ as it approaches the anterior wall and then merges into the Haversian systems of that wall. In the inner wall is a similar, narrower external band beginning near the posterior ridge, extending around the lateral, widening, curving inward toward the medullary canal, and merging into the Haversian systems of the anterior wall. These bands are the remains of the lamellar horseshoe. Their lacunæ are oval and narrow. Underneath these bands is an irregularly shaped ring of well developed Haversian systems forming nearly the whole width of the anterior and posterior wall. They communicate freely by cross canals and their lacunæ are well developed. The internal circumferential lamellæ surround the medullary canal as cancellous bone. In the lateral inner wall they widen and separate into laminæ, which spread toward the external surface and occupy half of the width of the wall in the widest place. The lacunæ are oval and narrow.

Type I-III, C.

RIGHT FEMUR OF A NEGRO. NO. 248674, U. S. NAT. MUS.

PL. 23, FIG. 325. SYN. TAB. VIII

Antero-posterior diameter of bone, 30 mm.; lateral, 26 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 12.5 mm.

There is little cancellous bone around the medullary canal. The bone is a little larger than the left femur.

The medullary canal is full. Medullary index, 32%.

Structure.—The external circumferential lamellæ are not distinct from the underlying structures. Beginning on both sides of the posterior ridge and extending around the section is a wide horseshoe-shaped band of laminæ and lamellæ. The toe of the shoe forms nearly the whole of the anterior wall and the heel nearly one-third of the posterior wall. In the outer lateral wall the heel of the shoe is composed of laminæ, separated by canals and crude Haversian systems. The laminæ gradually widen and increase in number and bend inwards nearly to the medullary canal as they reach the anterior wall. Here the laminar structure spreads out into a wide band of lamellæ which forms nearly all of the anterior wall. In this band are a great number of crude Haversian systems of the (Ia) differentiation arranged in concentric lines. After leaving the anterior, the lamellæ gradually become narrow until they form about one-third the width of the posterior wall. Underneath the horseshoe band is an irregularly shaped ring of Haversian systems which widens and forms nearly the whole posterior ridge. The systems are often separated by lamellæ. The internal circumferential lamellæ surround the medullary canal and are widest in the outer wall. The lacunæ are oval and narrow.

Type I-II-III, Ia, C.

LEFT FEMUR OF A NEGRO. NO. 248674, U. S. NAT. MUS.

PL. 24, FIG. 326. SYN. TAB. VIII

Antero-posterior diameter of bone, 29 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—Beginning on both sides of the posterior ridge and extending around the external portion of the section is a wide horseshoe-shaped band of laminæ, lamellæ, and Haversian systems. In the outer wall the heel is composed of a wide band of lamellæ, interrupted by a few Haversian systems of the (Ia) differentiation, and in the inner wall of laminæ with many systems of the same grade. The lamellar and laminar bands rapidly widen about the mid-lateral wall and bend inward nearly to the medullary canal as they reach the anterior and form the whole width of the anterior wall, excepting the internal circumferential lamellæ. In the anterior wall the lamellæ form a background which is thickly set with crude Haversian systems of the (Ia) differentiation. Underneath the horseshoe and between it and the medullary canal the following structures are found: In the inner wall short, wide, irregular bands appear, interrupted by Haversian systems, well developed. In the outer wall the systems are much more closely set and better developed. The posterior ridge is composed entirely of systems, well developed. The lacunæ are well developed.

The internal circumferential lamellæ surround the medullary canal, widest in the outer wall.

Type I-II-III, Ia, C.

Since the lamellar and laminar structures constitute such an important part of the femora of the negro, No. 248674, it was thought best to examine sections of all of the long bones of this negro in order to ascertain, if possible, whether or not the lamellar and laminar structures are accidental or characteristic of all the long bones of that individual. The following long bones have, therefore, been examined: Tibia and fibula, radius and ulna, humerus, clavicle and metatarsal bone of the great toe.

TIBIA OF NEGRO, NO. 248674, U. S. NAT. MUS.

PL. 24, FIG. 327. SYN. TAB. VIII

Structure.—Beginning with the inner ridge and extending laterally in both directions is a wide external band of lamellæ and laminæ, interrupted by Haversian systems of the (Ia) differentiation. A wide external band of lamellæ and laminæ also forms the boundary of the outer wall. The anterior and posterior walls are mostly Haversian systems. Underneath the horseshoe is an irregular central ring of Haversian systems, well developed. The internal circumferential lamellæ are arranged in places in the form of cancellous bone. The lacunæ are oval and long and the canaliculi are bushy. The tibia has practically the same type combination as the femur.

Type I-II-III, Ia, C.

FIBULA OF NEGRO, NO. 248674, U. S. NAT. MUS.

PL. 24, FIG. 328. SYN. TAB. VIII

Structure.—A wide lamellar and laminar band, interrupted in places by Haversian systems of the (Ia) and (C) differentiations, surrounds the bone, excepting the anterior wall where the Haversian systems form the circumference. The band is widest in the posterior wall. Underneath the band is an irregular ring of Haversian systems well developed. The lacunæ are oval and long. The internal circumferential lamellæ form the boundary of the medullary canal and are thickest in the posterior wall. The bone shows the same structure as the femur.

Type I-II-III, Ia, C.

ULNA OF NEGRO, NO. 248674, U. S. NAT. MUS.

PL. 24, FIG. 329. SYN. TAB. VIII

Structure.—The section is surrounded—posterior ridge excepted—by a wide horseshoe of lamellæ, interrupted by Haversian systems of the (Ia) and

(C) differentiation. The central ring is composed of well developed Haversian systems, separated in some places by laminæ. Internal circumferential lamellæ, wide in some places and interrupted by Haversian systems of the (Ia) differentiation, surround the central canal.

Type I-II-III, Ia, C.

RADIUS OF NEGRO, NO. 248674, U. S. NAT. MUS.

PL. 24, FIG. 330. SYN. TAB. VIII

Structure.—The section is surrounded by a wide horseshoe band of lamellæ, interrupted by scattering Haversian systems of the (Ia) and (C) differentiations. The central ring, narrow and irregular, is composed of Haversian systems and inter-Haversian lamellæ. The systems are well developed. Internal circumferential lamellæ of varying widths surround the central canal.

Type I-III, Ia, C.

HUMERUS OF NEGRO, NO. 248674, U. S. NAT. MUS.

PL. 24, FIG. 331. SYN. TAB. VIII

Structure.—About half of the section is composed of lamellæ, interrupted by scattering, well developed Haversian systems and Haversian systems of the (Ia) differentiation, and the remaining half of well developed Haversian systems. Internal circumferential lamellæ form a ring of varying widths around the medullary canal.

Type I-III, Ia, C.

CLAVICLE OF NEGRO, NO. 248674, U. S. NAT. MUS.

PL. 24, FIG. 332. SYN. TAB. VIII

Structure.—The section is about half surrounded by a wide band of lamellæ and laminæ, which alternate with concentric rows of Haversian systems. The remaining half is composed of well developed Haversian systems, separated in some places by short laminæ. External and internal circumferential lamellæ form narrow rings around the bone and central canal.

Type I-II-III, C.

METATARSAL BONE OF THE GREAT TOE. NEGRO, NO. 248674, U. S. NAT. MUS.

PL. 24, FIG. 333. SYN. TAB. VIII

Structure.—The inner one-half of the wall of the bone is composed of lamellæ with a few crude Haversian systems of the (Ia) differentiation. The outer half is composed of well developed Haversian systems between narrow external and internal circumferential lamellæ.

Type I-III, Ia, C.

Reviewing the long bones of this negro, No. 248674, it may be observed that they all conform to the first and third or first, second, and third types of structure, which types must be considered basic for this individual.

LEFT FEMUR OF A NEGRO. NO. 224713, U. S. NAT. MUS.

PL. 24, FIG. 334. SYN. TAB. VIII

Antero-posterior diameter of bone, 35 mm.; lateral, 24 mm.

Antero-posterior diameter of medullary canal, 20 mm.; lateral, 12 mm.

The medullary canal is full; cancellous bone is prominent in the posterior wall. Medullary index, 40%.

Structure.—The section is surrounded by a more or less fragmentary ring of lamellæ, laminæ, and Haversian systems. The ring is wide and broken by Haversian systems of the central ring in the posterior and inner wall. The central ring is composed of well developed Haversian systems and inter-Haversian lamellæ. Internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-II-III, Ia, C.

RIGHT FEMUR OF A NEGRO. NO. 83, MED. DEPT. TULANE UNIV.

PL. 25, FIG. 335. SYN. TAB. VIII

Antero-posterior diameter of bone, 30 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 12 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 19%.

Structure.—Beginning on both sides of the posterior ridge and extending around the section is a horseshoe of lamellæ, laminæ, and Haversian systems of the (Ia) and (C) differentiations. It is thin in the outer and thick in the remaining wall. The central ring is irregular and incomplete and composed of well developed Haversian systems with long, narrow lacunæ and straight canaliculi. The internal circumferential lamellæ form a very irregular ring, which, in the outer wall, spreads out into a curved, fan-shaped area of laminæ occupying most of that wall. The leaves of the fan then merge into a wide band of lamellæ, which bends inward to the medullary surface of the anterior wall. The fan encloses several complete Haversian systems and short canals.

Type I-II-III, Ia, C.

RIGHT FEMUR OF A NEGRO. NO 6, MED. DEPT. TULANE UNIV.

PL. 25, FIG. 336. SYN. TAB. VIII

Antero-posterior diameter of bone, 33.5 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 17%.

Structure.—With the exception of the posterior ridge, the section is surrounded by a band of lamellæ of varying widths, interrupted by Haversian systems of the (Ia) and (C) differentiations. On both sides of the ridge the lamellæ are separated into crude laminæ by short concentric canals. The lamellæ occupy nearly the whole of the anterior wall. The central ring is very irregular and limited to the posterior and inner wall. It is composed of well developed Haversian systems and inter-Haversian lamellæ.

Internal circumferential lamellæ form a very irregular ring around the medullary canal. In the outer wall it expands into a wide semicircular area of laminæ, interrupted by Haversian systems of the (Ia) and (C) differentiations.

Type I-II-III, Ia, C.

RIGHT FEMUR OF A NEGRO. NO. 63, MED. DEPT. TULANE UNIV.

PL. 25, FIG. 337. SYN. TAB. VIII

Antero posterior diameter of bone, 32 mm.; lateral, 28 mm.

Antero-posterior diameter of medullary canal, 20 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—A narrow ring of external circumferential lamellæ surrounds the bone. Beginning on the outer side of the posterior ridge and extending around the outer lateral and anterior wall is a wide band of lamellæ, laminæ, and Haversian systems. After leaving the anterior wall the lamellar band is displaced by Haversian systems and as the posterior wall is approached the lamellar band again appears. These interrupted bands are the remains of the horseshoe. Underneath the band is an incomplete central ring of well developed Haversian systems.

The internal circumferential lamellæ form an enclosing ring around the medullary canal. It is widest in the inner wall.

Type I-II-III, Ia, C.

LEFT FEMUR OF A NEGRO. NO. 5, MED. DEPT. TULANE UNIV.

PL. 25, FIG. 338. SYN. TAB. VIII

Antero-posterior diameter of bone, 25 mm.; lateral, 24 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 67%.

Structure.—A wide horseshoe band of lamellæ and laminæ, interrupted by Haversian systems of the (Ia) and (C) differentiations, surrounds the section. The band is narrow in the inner wall. The central ring is narrow and irregular and composed of Haversian systems and inter-Haversian lamellæ.

Internal circumferential lamellæ form an irregular ring around the medullary canal. In the inner wall they extend outward in an oblique direction and are separated by canals having the same direction.

Type I-II-III, Ia, C.

RIGHT FEMUR OF A NEGRO. NO. 8, MED. DEPT. TULANE UNIV.

PL. 25, FIG. 339. SYN. TAB. VIII

Antero-posterior diameter of bone, 27 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 12.5 mm.; lateral, 9 mm.

The bone is small. The medullary canal is full. Medullary index, 20%.

Structure.—On both sides of the posterior ridge are two wide external bands of lamellæ of unequal length. They are interrupted by small, crude Haversian canals of the (Ia) differentiation. The band of the inner increases in width as it reaches the anterior wall where it forms nearly the whole wall. It is then displaced by Haversian systems. The band of the outer wall is much shorter and is displaced by Haversian systems about the middle of the wall. The lacunæ are generally long. The Haversian systems of the section occupy irregularly shaped areas. The internal circumferential lamellæ form a wide ring around the medullary canal and it is crossed by frequent canals.

Type I-III, Ia, C.

LEFT FEMUR OF A NEGRO. NO. 7, MED. DEPT. TULANE UNIV.

PL. 25, FIG. 340. SYN. TAB. IX

Antero-posterior diameter of bone, 30 mm.; lateral, 26 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 50%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring constitutes practically the whole bone, and is composed of Haversian systems which show extensive senility. Around the medullary canal many systems have entirely disappeared, leaving irregularly shaped spaces.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

XIII. MAN—YELLOW-BROWN RACE

General Character of the Femur

With one exception the femora of the yellow-brown race are pre-Columbian. The series includes infantile, adolescent, and adult bones from the Pueblo, Chicama, and Pachacamac Indians.

The general shape of these femora is nearer circular than it is in the black or white races. The medullary canals were filled with marrow and cancellous bone. The medullary surfaces are irregular and corrugated. The medullary index varies from 19% to 100%, with an average of 43.8%.

Nearly all of the femora are composed of type combinations. The proportion of first type units is larger than it is in other races.

Detailed Examination

RIGHT FEMUR OF A PUEBLO INDIAN CHILD, ONE YEAR OLD. NO. 258675(z), U. S. NAT. MUS.

Pl. 25, Fig. 341. Syn. Tab. IX

Antero-posterior diameter of bone, 8 mm.; lateral, 7.5 mm.

Antero-posterior diameter of medullary canal, 4.5 mm.; lateral, 4 mm.

The medullary canal is full. Medullary index, 43%.

Structure.—Around the external portion of the section is a horseshoe-shaped band of crude Haversian systems in various stages of differentiation. Some are round, some elongated, and many are irregular in shape. Their Haversian canals of the (Ib) differentiation are relatively large and surrounded by lamellæ with oval lacunæ and rather infrequent canaliculi. The toe of the shoe is best developed and widest.

Underneath the Haversian band is a wider horseshoe band, forming the remainder of the section, and composed of laminæ, between which are concentric canals. In the anterior and outer wall the laminæ are assuming the shape of very much elongated Haversian systems. The posterior ridge is composed of crude, elongated Haversian systems, which extend from the external to the medullary surface and at right angles to the laminæ of the lateral wall. The systems have wide Haversian canals, surrounded by lamellæ with oval lacunæ and bushy canaliculi. A large vascular canal is seen in the inner posterior wall.

The internal circumferential lamellæ surround the medullary canal in the form of cancellous bone.

Type II-III, Ib.

RIGHT FEMUR OF A PUEBLO INDIAN CHILD, SIX YEARS OLD. NO. 258675(L), U. S. NAT. MUS.

PL. 25, FIG. 342. SYN. TAB. IX

Antero-posterior diameter of bone, 12 mm.; lateral, 10.5 mm.

Antero-posterior diameter of medullary canal, 8 mm.; lateral, 6 mm.

The medullary canal is full. Medullary index, 61%.

Structure.—Beginning on both sides of the posterior ridge and extending around the section is a horseshoe-shaped band of laminæ and lamellæ, interrupted by Haversian systems of the (Ia) differentiation. In the inner wall the band is composed of laminæ, separated by rather short, wide canals. The laminæ gradually merge into a narrow band of lamellæ as they pass around the inner lateral into the anterior wall. The band of lamellæ then widens in the outer wall and separates into laminæ, which form the whole width of the wall just before reaching the posterior ridge. The lacunæ are oval.

Underneath this band is a central ring of large, small, and irregularly shaped Haversian systems with inter-Haversian lamellæ. Many large canals occur which are irregular in shape and surrounded by clear areas of bone substance with few oval lacunæ. The systems communicate by canals which, in some portions, assume the form of a network. The ring reaches the external surface of the posterior ridge.

The internal circumferential lamellæ surround the medullary canal, excepting in the outer posterior wall where the systems form the border of the canal.

Type I-II-III, Ia, C.

LEFT FEMUR OF A PUEBLO INDIAN, TWELVE YEARS OLD. NO. 258675(S2), U. S. NAT. MUS.

PL. 25, FIG. 342½. SYN. TAB. IX

Antero-posterior diameter of bone, 17 mm.; lateral, 16 mm.

Antero-posterior diameter of medullary canal, 9 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—Around the outside of the section is a horseshoe-shaped band of lamellæ, separated into fragmentary laminæ by short concentric canals. The toe of the shoe is the widest part of the band and the heel of the inner is wider than that of the outer wall. The band is frequently interrupted by spaces of various sizes and shapes, the significance of which is not clear, and by Haversian systems of the (Ia) differentiation. The spaces are generally visible to the naked eye, and some of them are surrounded by clear areas crossed by a few canaliculi.

Underneath the horseshoe band is a central ring of incomplete Haversian systems with intervening lamellæ. The ring is also frequently interrupted by spaces similar to those mentioned above. The systems are round, oval, and irregular in shape with oval lacunæ and straight canaliculi. They communicate by cross canals. The posterior ridge is nearly all Haversian systems.

A ring of internal circumferential lamellæ of varying widths surrounds the medullary canal. In the lateral wall it spreads out into a fan-shaped area, which occupies about half the wall and is interrupted by a few canals.

Type I-II-III, Ia, C.

FEMUR OF A PUEBLO INDIAN, NO. 258675(x), U. S. NAT. MUS.

PL. 26, FIG. 343. SYN. TAB. IX

Antero-posterior diameter of bone, 20 mm.; lateral, 20 mm.

Antero-posterior diameter of medullary canal, 8 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 22%.

Structure.—The posterior ridge, not prominent, is composed of Haversian systems which are well developed. Beginning on both sides of the ridge and extending completely around the bone is a wide horseshoe of lamellæ, separating in places into laminæ, which are interrupted by Haversian systems of the (Ia) differentiation. The horseshoe varies in thickness. The toe constitutes two-thirds the width of the anterior wall, while the heel is considerably narrower. In the anterior wall the lamellæ are very frequently interrupted by elongated Haversian systems arranged concentrically. These systems are crude and of a low development.

Underneath the lamellar horseshoe is a central ring of complete Haversian systems. They are well developed with long, narrow lacunæ and straight canaliculi. Internal circumferential lamellæ enclose the medullary canal. In the posterior wall they form a wide band. In other situations they are reduced to a narrow ring.

Type I-II-III, Ia, C.

RIGHT FEMUR OF A PUEBLO INDIAN, ADULT. NO. 227339, U. S. NAT. MUS.

PL. 26, FIG. 344. SYN. TAB. IX

Antero-posterior diameter of bone, 25 mm.; lateral, 23 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 37%.

Structure.—The external circumferential lamellæ appear in scattered fragments around the section, and whole or half Haversian systems occupy the intervals between the fragments. The lacunæ are oval and long. A thick central ring of Haversian systems forms the chief part of the wall of the bone. The systems are well developed, their lacunæ are long and narrow. Extending across the prominence of the inner wall and forming its external boundary the Haversian systems are somewhat elongated and arranged in a direction parallel with the external surface of the bone. The internal circumferential lamellæ surround the medullary canal. Their lacunæ are long.

Type III, C.

LEFT FEMUR OF A PERUVIAN INDIAN. NO. 266469(b), U. S. NAT. MUS.

PL. 26, FIG. 345. SYN. TAB. IX

Antero-posterior diameter of bone, 27 mm.; lateral, 31 mm.

Antero-posterior diameter of medullary canal, 21 mm.; lateral, 19 mm.

The medullary canal is full. Medullary index, 91%.

Structure.—The section is surrounded by a narrow ring of external lamellæ. The inner wall is extended in the form of a ridge and is composed of laminæ parallel with the ridge surface. The laminæ are perforated by irregularly shaped spaces. The central ring is wide and composed of well developed Haversian systems, many of which are senile, especially those of the outer wall.

The internal circumferential lamellæ form an irregular ring around the medullary canal. In some places the lamellæ are indistinctly separated into laminæ.

Type I-II-III, C, senile.

LEFT FEMUR OF A PERUVIAN INDIAN. NO. 266469(a), U. S. NAT. MUS.

PL. 26, FIG. 346. SYN. TAB. IX

Antero-posterior diameter of bone, 22 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 12 mm.

The posterior ridge is small, while a very prominent heavy ridge occurs in the inner wall. This gives to the bone a peculiar shape.

The medullary canal is full. Medullary index, 36%.

Structure.—The external circumferential lamellæ are fragmentary. The section is composed almost entirely of well developed Haversian systems with some inter-Haversian lamellæ.

The internal circumferential lamellæ are fragmentary.

Type III, C.

LEFT FEMUR OF A CHICAMA INDIAN. NO 2, U. S. NAT. MUS.

PL. 26, FIG. 347. SYN. TAB. IX

Antero-posterior diameter of bone, 31 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 13 mm.

The walls of the bone are thick. Medullary index, 22%.

Structure.—A wide horseshoe of lamellæ, interrupted by Haversian systems of the (Ia) differentiation surrounds the section. The central ring, composed of large, small, and irregularly shaped Haversian systems, constitutes nearly all of the bone. A few senile systems appear. In the outer posterior wall elongated systems occur. The Haversian systems generally are separated by short lamellæ with oval lacunæ. The internal circumferential lamellæ, of varying widths and irregularities, crossed by radiating canals and interrupted by Haversian systems, surround the medullary canal.

Type I-III, Ia, C.

RIGHT FEMUR OF A CHICAMA VALLEY INDIAN OF PERU. NO. 3, U. S. NAT. MUS.

PL. 26, FIG. 348. SYN. TAB. IX

Antero-posterior diameter of bone, 27 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 11 mm.

Medullary index, 35%.

Structure.—The external circumferential lamellæ are incomplete. The central ring constitutes most all of the section and is composed of large, small, and irregularly shaped Haversian systems, between which are some inter-Haversian lamellæ with oval lacunæ. The lamellæ are most prominent in the anterior wall, and here the systems are somewhat elongated in cross-section.

The internal circumferential lamellæ are fragmentary.

Type I-III, C.

RIGHT FEMUR OF A CHICAMA INDIAN. NO. 1, U. S. NAT. MUS.

PL. 26, FIG. 349. SYN. TAB. IX

Antero-posterior diameter of bone, 26.5 mm.; lateral, 31 mm.

Antero-posterior diameter of medullary canal, 11 mm.; lateral, 16 mm.

Medullary index, 27%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring constitutes nearly all of the section and is composed of Haversian systems, large, small, and irregular. In the outer wall they have a more or less elongated shape arranged concentrically and separated by short lamellæ with oval lacunæ.

The posterior ridge is composed of Haversian systems with inter-Haversian bone substance and oval lacunæ.

A ring of internal circumferential lamellæ surrounds the medullary canal.

Type III, C.

LEFT FEMUR OF A CHICAMA INDIAN. NO. 4, U. S. NAT. MUS.

PL. 26, FIG. 350. SYN. TAB. IX

Antero-posterior diameter of bone, 30 mm.; lateral, 28 mm.

Antero-posterior diameter of medullary canal, 18 mm.; lateral, 16 mm.

Medullary index, 52%.

Structure.—Beginning on the outer side of the posterior ridge is a wide band of lamellæ in which are many Haversian systems. The band occupies about one-half of the wall and is gradually displaced by Haversian systems in the anterior wall. In the inner wall the continuation of the band is indicated by concentric rows of elongated systems. Underneath the band is a central ring of Haversian systems with senile changes. Many canals extend in all directions in the two bands. The two bands taken together are the remains of the horseshoe of lamellæ so often present in the lower types of bone. The posterior ridge is composed of small, irregularly shaped Haversian systems with inter-Haversian lamellæ.

A narrow band of internal circumferential lamellæ surrounds the medullary canal.

Type I-III, C, senile.

LEFT FEMUR OF AN ADOLESCENT CHICAMA INDIAN. NO. 7, U. S. NAT. MUS.

PL. 27, FIG. 351. SYN. TAB. IX

Antero-posterior diameter of bone, 18.5 mm.; lateral, 19 mm.

Antero-posterior diameter of medullary canal, 10.5 mm.; lateral, 9 mm.

Medullary index, 37%.

Structure.—The external circumferential lamellæ, interrupted by Haversian systems surround the section. The central ring is composed of lamellæ and Haversian systems. In the anterior wall the toe of the shoe is for the most part displaced by Haversian systems. A wide ring of internal circumferential lamellæ surrounds the medullary canal. In the inner wall the lamellæ become laminæ. The posterior ridge is composed of elongated Haversian systems.

Type I-II-III, C.

* LEFT FEMUR OF A CHICAMA INDIAN. NO. 9, U. S. NAT. MUS.[1]

SYN. TAB. IX

Antero-posterior diameter of bone, 22 mm.; lateral, 23.5 mm.

Antero-posterior diameter of medullary canal, 11 mm.; lateral, 11 mm.

Medullary index, 30%.

Structure.—A horseshoe of lamellæ, laminæ, and crude Haversian systems surrounds the section. The toe of the shoe is narrow and the heel wide.

The central ring is wide and composed of small and large irregularly shaped Haversian systems with short inter-Haversian lamellæ, numerous canals, and spaces.

[1] The femora marked (*) have been described, but not drawn.

The internal circumferential lamellæ enclose the medullary canal. It is a fairly wide band in the lateral walls. The lacunæ of the section are generally oval.

Type I-II-III, Ia, C.

* RIGHT FEMUR OF AN ADULT PACHACAMAC INDIAN. NO. 14, U. S. NAT. MUS.

SYN. TAB. IX

Antero-posterior diameter of bone, 24 mm.; lateral, 21 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 10 mm.

Medullary index, 38%.

Structure.—Slight evidences of the horseshoe band are present. The lamellæ are most pronounced in the anterior wall where they form a fairly wide band. In the lateral wall the lamellæ are separated into laminæ, between which are small Haversian systems of the (Ia) differentiation.

The central ring is composed of Haversian systems. In the outer and inner wall inter-Haversian lamellæ are present. The internal circumferential lamellæ enclose the medullary canal. In the outer wall they expand into a wide crescent, which is broken into irregularly shaped fragments by interrupting Haversian systems. The lacunæ are long, narrow, and oval.

Type I-II-III, Ia, C.

* RIGHT FEMUR OF A PACHACAMAC INDIAN. NO. 13, U. S. NAT. MUS.

SYN. TAB. IX

Antero-posterior diameter of bone, 16 mm.; lateral, 15 mm.

Antero-posterior diameter of medullary canal, 8 mm.; lateral, 7 mm.

Medullary index, 30%.

Structure.—The section is surrounded, with the exception of the posterior ridge, by a horseshoe band of laminæ in the outer and anterior wall and of Haversian systems of the (Ia) differentiation in the inner wall. The laminæ are frequently perforated by small canals and in the anterior wall they suddenly widen and occupy the whole wall. As they approach the inner wall they bend around the inner anterior angle and are then displaced by very crude Haversian systems.

The central ring is reduced to a crescent in the outer wall. It is composed of crude Haversian systems and lamellæ.

The posterior ridge is not distinguishable from the lateral wall and consists of Haversian systems and short laminæ having a direction parallel with the external surface.

The internal circumferential lamellæ surround the medullary canal. They expand in both lateral walls into two wide crescents composed of wide lamellar bands and crossed by numerous canals from the medullary surfaces. The lacunæ of all parts are oval.

Type II-III, Ia, C.

* LEFT FEMUR OF AN ADOLESCENT PACHACAMAC INDIAN. NO. 8, U. S. NAT. MUS.

SYN. TAB. IX

Antero-posterior diameter of bone, 22.5 mm.; lateral, 18 mm.

Antero-posterior diameter of medullary canal, 9 mm.; lateral, 7 mm.

Medullary index, 19%.

Structure.—The remains of the external horseshoe of lamellæ are evident. In this section the lamellæ are separated into laminæ which are interrupted by frequent Haversian systems.

The central ring is wide and composed of well developed Haversian systems with very little inter-Haversian lamellæ. There are many canals running in various directions.

A narrow ring of internal circumferential lamellæ encloses the medullary canal. The lacunæ are oval and round.

Type II-III, C.

* RIGHT FEMUR OF A PACHACAMAC INDIAN CHILD. NO. 11, U. S. NAT. MUS.

SYN. TAB. IX

Antero-posterior diameter of bone, 10 mm.; lateral, 9 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 6.5 mm.

Medullary index, 100%.

Structure.—The section is composed of lamellæ and laminæ in the form of a horseshoe embracing the posterior ridge. The shoe is crossed by canals and interrupted by Haversian systems which are developing from the vascular canals. The lacunæ are oval and round. The posterior ridge is composed of developing Haversian systems, between which are coarse canaliculi and large, round lacunæ embedded in bone substance. The ridge is distinctly marked off from the enclosing laminæ.

Type II-III, Ia, Ib.

LEFT FEMUR OF A PACHACAMAC INDIAN CHILD. NO. 12, U. S. NAT. MUS.

PL. 27, FIG. 357. SYN. TAB. IX

Antero-posterior diameter of bone, 10 mm.; lateral, 12.5 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 7.5 mm.

Medullary index, 72%.

Structure.—With the exception of the posterior ridge the section is surrounded by a band of laminæ and Haversian systems. In the outer wall the laminæ are perforated by small longitudinal canals.

The central ring forms nearly all of the inner wall and little or none of the outer wall. It is composed of crude Haversian systems. The systems are irregular in shape with oval lacunæ.

The posterior ridge has blended with the lateral walls and is composed of crude Haversian systems. The lacunæ are oval.

The internal circumferential lamellæ enclose the medullary canal.

Type II-III, Ib.

* RIGHT FEMUR OF AN ADULT PACHACAMAC INDIAN. NO. 10, U. S. NAT. MUS.

SYN. TAB. IX

Antero-posterior diameter of bone, 21.5 mm.; lateral, 20 mm.

Antero-posterior diameter of medullary canal, 10.5 mm.; lateral, 8.5 mm.

Medullary index, 23%.

Structure.—The horseshoe band around the section is evident. It is composed of a lamellar background, most pronounced in the inner and anterior wall, interrupted by numerous irregularly shaped Haversian systems.

The central ring is composed of Haversian systems.

The medullary canal is enclosed by internal circumferential lamellæ which expand into a crescent in the inner wall. It is crossed by radiating canals and interrupted by scattering Haversian systems. The lacunæ are oval.

Type I-III, Ia, C.

* LEFT FEMUR OF A PACHACAMAC INDIAN. NO. 5, U. S. NAT. MUS.

SYN. TAB. IX

Antero-posterior diameter of bone, 20 mm.; lateral, 21 mm.

Antero-posterior diameter of medullary canal, 11 mm.; lateral, 9 mm.

Medullary index, 31%.

The bone is adolescent.

Structure.—The section is surrounded by external circumferential lamellæ. Many canals enter the section from the external surface. Here and there an Haversian system appears. The lacunæ are oval and round.

The central ring is composed of short lamellæ and irregularly shaped Haversian systems which are still undeveloped. Their lacunæ are oval and round.

The internal circumferential lamellæ surround the medullary canal. In the outer wall the lamellæ take the form of a crescent which occupies half of the width of the wall. Near the anterior wall the lamellæ of the crescent cross the medullary canal as a narrow band. The crescent is interrupted by a few Haversian systems. The lacunæ are long and narrow.

Type I-III, Ia, C.

RIGHT FEMUR OF A PACHACAMAC INDIAN. NO. 15, U. S. NAT. MUS.

PL. 27, FIG. 360. SYN. TAB. IX

Antero-posterior diameter of bone, 24 mm.; lateral, 20 mm.

Antero-posterior diameter of medullary canal, 12 mm.; lateral, 9 mm.

Medullary index, 27%.

Structure.—The section is surrounded, with the exception of the posterior ridge, by a horseshoe of lamellæ and Haversian systems of the (Ia) and (C) differentiations. The shoe becomes narrowest at the junction of the anterior and outer wall where it is displaced by a wide expansion of the internal lamellæ.

The central ring, irregular in width, is composed of Haversian systems and inter-Haversian lamellæ.

The internal circumferential lamellæ form a wide, irregular ring around the medullary canal.

In the outer wall it expands into a wide crescent composed of lamellæ indistinctly separated into laminæ.

The lacunæ are oval.

Type I-III, Ia, C.

LEFT FEMUR OF AN ADOLESCENT PACHACAMAC INDIAN. NO. 7, U. S. NAT. MUS.

PL. 27, FIG. 361. SYN. TAB. IX

Antero-posterior diameter of bone, 20.5 mm.; lateral, 18.5 mm.

Antero-posterior diameter of medullary canal, 9 mm.; lateral, 7 mm.

The bone is adolescent. Medullary index, 20%.

Structure.—The section is surrounded by external circumferential lamellæ, which are very frequently interrupted by small, crude Haversian systems. In the posterior ridge the lamellæ are deficient.

The central ring is wide and composed of irregularly shaped Haversian systems, cross canals, and short inter-Haversian lamellæ with oval lacunæ. The internal circumferential lamellæ enclose the medullary canal. In the outer wall they assume the form of a crescent and are crossed by frequent radiating canals.

Type I-III, C.

RIGHT FEMUR OF A JAPANESE MALE. NO. 245, CR. MED. COLL.

PL. 27, FIG. 362. SYN. TAB. IX

Antero-posterior diameter of bone, 30 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 20 mm.; lateral, 18 mm.

The medullary canal is full. Medullary index, 65%.

Structure.—The external circumferential lamellæ form an enclosing ring of various widths. It is widest in the anterior and inner wall, and is interrupted by Haversian canals of the (Ia) differentiation. The central ring is composed of Haversian systems, large and small, interrupted by irregularly shaped areas of lamellæ. Numerous vascular canals occur, and some senile systems appear. The internal circumferential lamellæ form a fragmentary ring around the medullary canal.

Type I-III, Ia, C, senile.

XIV. MAN—ANCIENT EGYPTIAN

Nine femora were examined.

General Character of the Femur

The Egyptian femora were taken from the cemeteries of Egypt of the Twelfth Dynasty (2000 B. C.). The series includes the femora of the child, adolescent, and adult.

The femora are rather small in size and variable in shape.

The medullary surface is less corrugated than it is in modern white bones.

The medullary index varies from 27% to 111%, with an average of 39.5%.

The type varies from a third to a second and third, or first and third, depending upon the age in years. The femur of a child about one year old shows the formation of Haversian systems directly from the circulation. It is the only femur examined which shows such an origin (figs. 363 and 363a, pl. 27). This formation of the Haversian system is especially interesting.

Detailed Examination

FEMUR OF AN EGYPTIAN CHILD, ONE YEAR OLD. NO. 256479(de) U. S. NAT. MUS.

PL. 27, FIG. 363. SYN. TAB. IX

Antero-posterior diameter of bone, 9 mm.; lateral, 11.5 mm.

Antero-posterior diameter of medullary canal, 7 mm.; lateral, 8 mm.

The medullary canal is full. Medullary index, 111%.

Structure.—The section shows three concentric, parallel groups of blood vessels. One group is near the external surface (fig. 363D), a second occupies the middle of the wall (fig. 363E), and the third is near the medullary canal (fig. 363F). From these groups of vessels small branches originate, and from the branches intricate plexuses of minute vessels are formed and occupy the intervals between the groups of large vessels. The posterior wall is composed, almost entirely, of plexuses of blood vessels and a little bone substance with a few oval lacunæ between them. Figure 363a is an enlarged drawing of figure 363A. In this bone may be seen an Haversian system formation unlike any noticed in other femora. A short branch is given off from one of the large concentric vessels (figs. 363-1 and 363a1) and divides into small branches, which assume a circular arrangement (fig. 363a2). The small branches send off numerous twigs which break into capillaries and surround a central opening (fig. 363a3). This gives the whole figure a circular form. Slight enlargements of the peripheral capillaries are nipped off at intervals, from which arise many minute canals (fig. 363a4). The enlargements become lacunæ and the minute canals canaliculi (fig. 363a5). The lacunæ are round and the canaliculi are long and straight.

From this it would appear that the foundations of Haversian systems are laid in the vascular system. Osteoblasts either lodge in the capillaries or are produced by endothelium, and by growth and obstruction to the circulation, separate, throw out processes, and secrete bone substance in which they are enclosed. In this manner an Haversian system seems to be formed. These developments take place in the concentric intervals or rings between the concentric groups of vessels and transform them into bone (fig. 363B). In this femur the intervals between the three vascular groups are occupied by Haversian systems. At quite regular intervals large, irregularly shaped spaces occur, the significance of which does not appear (fig. 363C). Although this bone presents great vascularity, yet it is hard enough to be sawed. Around the external and medullary surfaces the bone formation is farther advanced. Lamellæ are beginning to be evident in these regions.

Type III, Ia, Ib.

FEMUR OF AN EGYPTIAN CHILD. NO. 256479(d), U. S. NAT. MUS.

PL. 27, FIG. 364. SYN. TAB. IX

Antero-posterior diameter of bone, 9.5 mm.; lateral, 10 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 27%.

Structure.—The bone is nearly round. The posterior ridge is coarsely serrated on its external surface. The serrations consist of projecting loops of lamellæ, enclosing long, elliptical canals and presenting the appearance of rather crude Haversian systems. Underneath the serrated border the ridge is composed of bone substance enclosing more or less circularly shaped spaces. Some of these spaces and lamellæ present outlines of crude Haversian systems. The lacunæ are round and oval and the canaliculi are short and bushy. Beginning on one side of the posterior ridge and extending around the external surface of the bone to the opposite side are a few rather coarse laminæ with undulating borders, frequently interrupted by small Haversian systems formed by bending lamellæ of the laminæ around the central canals. The systems are elliptical. Under the external laminæ the bone is composed of channelled bone substance, with large meshes visible to the naked eye and having a concentric horseshoe arrangement. Underneath this is a narrow concentric lamina with long lacunæ, and under this again is a wide ring of channelled bone substance resembling the external one, but rather more advanced. Around the medullary canal is a very narrow ring of lamellæ. The arrangement of the several rings of thin bone correspond to the groups of vessels and inter-vascular structures seen in figure 363, and appears to be a more complete formation.

Type I-II-III, Ia, Ib.

RIGHT FEMUR OF AN EGYPTIAN. NO. 256479(a3), U. S. NAT. MUS.

PL. 27, FIG. 365. SYN. TAB. IX

Antero-posterior diameter of bone, 12 mm.; lateral, 12.5 mm.

Antero-posterior diameter of medullary canal, 5.5 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 35%.

This femur belongs to the same series and shows a further advancement, since the cancellous structure has disappeared and a compact bone has taken its place.

Structure.—The posterior ridge is composed of Haversian systems and vascular canals. Their lacunæ are narrow and their canaliculi are long.

Beginning on one side of the posterior ridge and extending around the section to the other side is a horseshoe band of lamellæ of varying widths. It is widest in the posterior wall and remains of uniform width in other situations. The lamellæ are interrupted by Haversian systems of the (Ia) differentiation. Underneath the lamellar band is the middle ring of Haversian systems and inter-Haversian lamellæ. Around the medullary canal is a wide band of lamellæ with long lacunæ and straight canaliculi. This bone is more lamellar than Haversian system, but it shows a much more advanced stage of formation than those preceding. The completed units have appeared.

Type I-III, Ia, C.

FEMUR OF AN EGYPTIAN. NO. 258675(a), U. S. NAT. MUS.

PL. 27, FIG. 366. SYN. TAB. IX

Antero-posterior diameter of bone, 18 mm.; lateral, 16.5 mm.

Antero-posterior diameter of medullary canal, 10 mm.; lateral, 9 mm.

The bone belongs to the same series as the foregoing.

The medullary canal is full. Medullary index, 44%.

Structure.—The section is composed of wide external and internal lamellæ with a central ring of Haversian systems. The enclosing horseshoe-shaped band of lamellæ is clearly marked. It is fairly uniform in width, and interrupted by crude Haversian systems of the (Ia) differentiation. Around the medullary canal is a wide ring of lamellæ of varying widths. It is widest in the inner wall and interrupted by a few incomplete Haversian systems. Between these two bands of lamellæ is a narrow middle ring of Haversian systems and inter-Haversian lamellæ. The lacunæ are oval and long and their canaliculi are long.

Type I-III, Ia, C.

RIGHT FEMUR OF AN ADULT EGYPTIAN. NO. 256481(d), U. S. NAT. MUS.

PL. 28, FIG. 367. SYN. TAB. IX

Antero-posterior diameter of bone, 18.5 mm.; lateral, 17.5 mm.

Antero-posterior diameter of medullary canal, 9 mm.; lateral, 8 mm.

The medullary canal is full. Medullary index, 28%.

Structure.—The bone is surrounded by a lamellar ring, within which are a few Haversian systems of the (Ia) and (C) differentiations. The ring is separated by concentric canals into laminæ.

The medullary canal is surrounded by a wide band of lamellæ with long lacunæ and straight canaliculi, which in the inner wall rather abruptly widens into a semicircular area of laminæ occupying nearly the whole thickness of the wall. The laminæ are interrupted by numerous Haversian systems of the (Ia) differentiation. Between these two bands is an irregularly shaped central ring of Haversian systems and inter-Haversian lamellæ. The lacunæ are long and narrow and their canaliculi are long.

Type I-II-III, Ia, C.

LEFT FEMUR OF AN ADULT EGYPTIAN. NO. 256481(a), U. S. NAT. MUS.

PL. 28, FIG. 368. SYN. TAB. IX

Antero-posterior diameter of bone, 18 mm.; lateral, 16 mm.

Antero-posterior diameter of medullary canal, 8 mm.; lateral, 7 mm.

The medullary canal is full. Medullary index, 24%.

The bone is very hard and brittle instead of chalky like the other femora described. It is small and nearly round.

Structure.—The posterior ridge, which is not very prominent, is composed of well developed Haversian systems.

Beginning on either side of this ridge and extending completely around the bone is a very wide horseshoe-shaped band of lamellæ with long lacunæ and straight canaliculi. It forms more than half the thickness of the wall of the bone. It is perforated at frequent intervals by irregularly shaped spaces or openings, surrounded by very narrow rims of lamellæ. The openings are more numerous in the inner wall where they take a concentric arrangement. Between the openings are Haversian systems which are wide apart in the inner and close together in the outer wall. The lamellæ are clearly marked, their lacunæ are long and oval and the canaliculi are very numerous, long, and branching. The Haversian systems are well developed.

This wide lamellar band is distinctly distinguished from the narrow, central ring of Haversian systems underneath. The systems are somewhat irregular in shape, but well developed. In all of them the canaliculi are extremely numerous. The internal circumferential lamellæ surround the medullary canal. They form a thick band in the inner wall, a narrower band in the outer, and a narrow rim in the anterior and posterior wall.

The bone, therefore, has three concentric rings in section, an extremely wide lamellar ring over half the thickness, a narrow central Haversian ring one-fourth the thickness, and an irregular ring of internal circumferential lamellæ.

Type I-III, Ib, C, senile.

RIGHT FEMUR OF AN ANCIENT EGYPTIAN. NO. 258675(e), U. S. NAT. MUS.

PL. 28, FIG. 369. SYN. TAB. IX

Antero-posterior diameter of bone, 26 mm.; lateral, 21.5 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 44%.

The bone is chalky. The femur is pear-shaped in cross-section.

Structure.—The posterior ridge is composed of large, uniformly developed Haversian systems and large, vascular canals surrounded by a few concentric lamellæ.

Beginning on both sides of the ridge and extending around the section is a wide horseshoe of lamellæ with long lacunæ and straight canaliculi, frequently interrupted by Haversian systems. The toe of the shoe forms nearly all of the anterior, and the heel, half of the posterior wall. The lacunæ are long, narrow and oval and their canaliculi are long and closely branching. Underneath the horseshoe, between it and the internal circumferential lamellæ, is an irregularly shaped crescent of Haversian systems situated eccentrically.

The internal circumferential lamellæ surround the medullary canal.

In the inner wall the internal lamellæ widen abruptly and occupy one-third of the width of the wall. In the anterior, outer, and posterior wall they form a narrow band around the medullary canal. The lacunæ and canaliculi are well developed.

Type I-III, C.

FEMUR OF AN ADULT EGYPTIAN. NO. 256478(23), U. S. NAT. MUS.

PL. 28, FIG. 370. SYN. TAB. IX

Antero-posterior diameter of bone, 24 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 10 mm.; lateral, 10 mm.

The bone is chalky.

The medullary canal is full. Medullary index, 16%.

Structure.—The external circumferential lamellæ surround the bone. Their lacunæ are long and narrow and their canaliculi are long and branching.

The central ring, of well developed Haversian systems, forms nearly the whole thickness of the wall of the bone. The systems are close together, which means that there are little or no inter-Haversian lamellæ, and they are generally large and uniform in size and shape. Their lacunæ are long and narrow and their canaliculi are long and branching, or the lacunæ may be oval and their canaliculi short and bushy.

The internal circumferential lamellæ surround the medullary canal. The ring varies in thickness.

Type III, C.

RIGHT FEMUR OF AN ADULT EGYPTIAN. NO. 256478(X), U. S. NAT. MUS.

PL. 28, FIG. 371. SYN. TAB. IX

Antero-posterior diameter of bone, 23 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 12 mm.; lateral, 11 mm.

The femur is small. The medullary canal is full. Medullary index, 27%.

Structure.—The external circumferential lamellæ are fragmentary. Beginning on the inner side of the posterior ridge and extending around the external surface of the inner lateral wall is a band of lamellæ enclosing Haversian systems. As the band reaches the mid-lateral wall it is displaced by Haversian systems. In the inner anterior wall concentric systems and lamellæ alternate. The remaining portion of the section is composed of Haversian systems somewhat irregular in shape and size. The lacunæ are oval in some places and narrow in others, the oval predominating. The external part of the posterior ridge is composed of large, oval lacunæ with bushy canaliculi.

The internal circumferential lamellæ are fragmentary. The evidence of the lamellar horseshoe is present to a small extent as a background in the inner wall, while the section is nearly all Haversian systems.

Type I-III, C.

XV. MAN—MODERN WHITE

General Character of the Femur

The femora of the white race vary in shape to a marked degree. The medullary canals occupy central, eccentric, and oblique positions. They are filled with cancellous bone and marrow. The medullary surfaces are very uneven. The average medullary index is 35.8%.

The type of structure varies from the third to the first and third. A great many first and third type combinations are found in the various femora, and the proportions of the first to the third type vary greatly. In some, it forms a narrow surrounding band; in others, the band increases in thickness until it forms a quarter, third, half, or more than half of the whole section; in still others, it remains as a background of inter-Haversian lamellæ.

Detailed Examination

FEMUR OF A WHITE MALE, NO. 1629, U. S. NAT. MUS.

Pl. 28, Fig. 372. Syn. Tab. X

Antero-posterior diameter of bone, 28 mm.; lateral, 28 mm.

Antero-posterior diameter of medullary canal, 18 mm.; lateral, 17 mm.

The medullary canal is full. Medullary index, 64%.

Structure.—The external circumferential lamellæ form a very narrow ring around the section. Beginning a little to the inner side of the posterior ridge and extending around the inner wall, beneath the external circumferential lamellæ, is a narrow band of elliptical Haversian systems in cross-section. They disappear as they approach the anterior wall. These structures are the remains of the lamellæ and laminæ seen so frequently in lower bones in the same situation. The middle ring of the section is composed of well developed Haversian systems with many communicating canals. The medullary canal is surrounded by a narrow ring of internal circumferential lamellæ. The lacunæ and canaliculi are generally well developed.

Type III, C.

RIGHT FEMUR OF A WHITE FEMALE. NO. 147, MED. DEPT. NORTHWESTERN UNIV.

Pl. 28, Fig. 373. Syn. Tab. X

Antero-posterior diameter of bone, 33.5 mm.; lateral, 32 mm.

Antero-posterior diameter of medullary canal, 19 mm.; lateral, 18.5 mm.

The medullary canal is surrounded by cancellous bone and is full. Medullary index, 49%.

Structure.—External circumferential lamellæ appear only in scattered fragments. They are most pronounced in the posterior inner wall. The central ring of well developed Haversian systems constitutes practically the whole bone. In most parts they form the external border directly under the periosteum, and here and there a half system bounds the section. The systems are fairly uniform in size and circular in cross-section. Many of these have relatively large Haversian canals and show slight senile changes. The Haversian canals frequently communicate by cross canals. On the two sides of the posterior ridge, near the circumference, they are a little elongated and show faint traces of a former laminar condition.

The internal circumferential lamellæ form a narrow ring around the medullary canal. For the most part the lamellæ assume the form of cancellous bone. All bone units are well developed.

Type III, C, senile.

RIGHT FEMUR OF A WHITE CHILD, LESS THAN ONE YEAR OLD. NO. 249588, U. S. NAT. MUS.

PL. 29, FIG. 374. SYN. TAB. X

Antero-posterior diameter of bone, 6.5 mm.; lateral, 7.5 mm.

Antero-posterior diameter of medullary canal, 4 mm.; lateral, 5 mm.

The medullary canal is full. Medullary index, 70%.

Structure.—Extending around the circumference of the section—posterior ridge excepted—is a narrow ring of lamellæ with oval lacunæ and bushy canaliculi. The lamellæ are frequently interrupted by canals running longitudinally.

Beginning on both sides of the posterior ridge and extending around the section underneath the external lamellæ is a horseshoe band of laminæ and Haversian systems forming the remainder of the bone. The inner wall is almost entirely laminæ. As the laminæ reach the anterior wall they are mostly displaced by rather crude, elongated Haversian systems, which, however, generally maintain concentric arrangements. In the outer wall the Haversian systems occupy the medullary half and the laminæ the circumferential half of the section. The lacunæ are oval. The Haversian canals are irregular in shape and extend in various directions. The internal circumferential lamellæ are fragmentary.

The posterior ridge is incompletely formed and is composed of large canals, surrounded by oval lacunæ with infrequent bordering canaliculi. Here and there an Haversian system appears. The ridge is obviously a later formation than the remaining walls.

Type II-III, Ia, Ib.

FEMUR OF A WHITE MALE. NO. 53, CR. MED. COLL.

PL. 29, FIG. 375. SYN. TAB. X

Antero-posterior diameter of bone, 28 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 17 mm.

Cancellous bone surrounds the medullary canal and is most prominent in the anterior wall. The medullary canal is full. Medullary index, 48%.

Structure.—The external circumferential lamellæ surround the bone at scattered intervals. Their lacunæ are long and narrow and their canaliculi are long. The central ring, constituting nearly the entire thickness of the wall of the bone, is composed of Haversian systems, which, in places, form the external boundary of the bone. At some points in the periphery, only half or three-quarter systems appear directly under the periosteum. The systems vary in size, but are highly developed. Their lacunæ are long and narrow and their canaliculi are long. The Haversian canals intercommunicate. The internal circumferential lamellæ surround the medullary canal in the form of cancellous bone.

Type III, C.

RIGHT FEMUR OF A WHITE MALE. NO. 171, MED. DEPT. NORTHWESTERN UNIV.

PL. 29, FIG. 376. SYN. TAB. X

Antero-posterior diameter of bone, 30 mm.; lateral, 33 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 35%.

Structure.—The external circumferential lamellæ appear in fragments.

The section is composed almost entirely of Haversian systems with very little inter-Haversian lamellar structure. The systems vary in size and some of them show senile changes.

The internal circumferential lamellæ form a very narrow ring around the medullary canal. The bone is high in development, since practically all lamellar and laminar formations have disappeared and Haversian systems have taken their places. It shows, however, senile changes.

Type III, C, senile.

LEFT FEMUR OF A WHITE MAN. NO. 95, CR. MED. COLL.

PL. 29, FIG. 377. SYN. TAB. X

Antero-posterior diameter of bone, 30 mm.; lateral, 27.5 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 16 mm.

The medullary canal is full. Medullary index, 42%.

Structure.—The external circumferential lamellæ appear in fragments. The central ring is composed of Haversian systems and constitutes almost the entire wall of the bone. Many systems are senile. They reach the external surface between the lamellar fragments and form the posterior ridge. They are large, small, and irregular in shape and frequently communicate by canals. Their lacunæ are narrow and oval. Around the internal circumferential lamellæ the systems show senile changes. There is very little inter-Haversian structure.

The internal circumferential lamellæ form a very narrow ring around the medullary canal.

Type III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 96, CR. MED. COLL.

PL. 29, FIG. 378. SYN. TAB. X

Antero-posterior diameter of bone, 29.5 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 14.5 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 24%.

Structure.—A few fragments of the external circumferential lamellæ appear here and there around the surface of the bone. The central ring of Haversian systems constitutes almost entirely the whole section.

There are some inter-Haversian lamellæ which are the remains of the laminar and lamellar structures seen in lower bones. The systems are large, small, and irregular in shape and frequently communicate by canals. Some of them show senile changes. On the whole, they are well developed.

The internal circumferential lamellæ form a very narrow, irregular ring around the medullary canal. It is displaced at intervals by Haversian systems of the central ring.

Type III, C, senile.

LEFT FEMUR OF A WHITE MALE, AGE 45. NO. 168, MED. DEPT. NORTHWESTERN UNIV.

PL. 29, FIG. 379. SYN. TAB. X

Antero-posterior diameter of bone, 30 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 17 mm.

The medullary canal is full. Medullary index, 40%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring is composed of large, small, and irregularly shaped Haversian systems, many of which show senile changes. The internal circumferential lamellæ form a narrow fragmentary ring around the medullary canal.

Type III, C, senile.

LEFT FEMUR OF A WHITE MALE, AGE 50. NO. 10, MED. DEPT. NORTHWESTERN UNIV.

PL. 29, FIG. 380. SYN. TAB. X

Antero-posterior diameter of bone, 30 mm.; lateral, 31.5 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 20%.

Structure.—The external circumferential lamellæ appear only in short fragments. The central ring is composed of large, small, and irregular Haversian systems with many senile changes. The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

FEMUR OF A SENILE WHITE AMERICAN FEMALE, AGE 52. NO. 227876, U. S. NAT. MUS.

PL. 29, FIG. 381. SYN. TAB. X

Antero-posterior diameter of bone, 22 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 13.5 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 42%.

There is a difference of eight years between the senile femora of figures 381 and 382. The two femora have about the same external diameter, but figure 381 has an index of 42%, and figure 382, 74%.

Structure.—Femur (fig. 381) is of a slightly lower type of structure than figure 382. This may be seen by the concentric arrangement of the oblong Haversian systems of the inner wall. The external circumferential lamellæ are fragmentary. The central ring is composed of large and small Haversian systems in different stages of senility. A few are normal; that is, their Haversian canals are about the usual size. Some have large Haversian canals and crescent-shaped lamellæ; some have large canals and narrow rings of granular lamellæ; some have large canals and perfectly black, opaque rings or crescents around them; and some are entirely gone.

The internal circumferential lamellæ are fragmentary.

Type III, C, senile.

FEMUR OF A SENILE WHITE FEMALE, AGE 60. NO. 227880, U. S. NAT. MUS.

PL. 29, FIG. 382. SYN. TAB. X

Antero-posterior diameter of bone, 24 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 16 mm.

Cancellous bone is present in places. The bone is extremely soft, light, and thin-walled. The medullary canal is relatively large. In the wall of the bone are large, irregularly shaped spaces.

The medullary canal is full. Medullary index, 74%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring is composed of large, small, and irregularly shaped Haversian systems, most of which show marked degrees of senility. Some are black and partly gone and others have entirely disappeared, leaving spaces. The internal circumferential lamellæ are fragmentary, appearing only here and there.

Type III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 162, MED. DEPT. NORTHWESTERN UNIV.

PL. 30, FIG. 384. SYN. TAB. X

Antero-posterior diameter of bone, 25 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 35%.

Structure.—The external circumferential lamellæ are fragmentary.

The central ring is composed of Haversian systems of various shapes and sizes with round and oval lacunæ and bushy and straight canaliculi, many of which are senile.

The internal circumferential lamellæ with long, narrow lacunæ and straight canaliculi surround the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 244, CR. MED. COLL.

PL. 30, FIG. 385. SYN. TAB. X

Antero-posterior diameter of bone, 35 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 32%.

Structure.—Slight remains of the lamellar horseshoe are found on both sides of the posterior ridge.

The external circumferential lamellæ are fragmentary.

The central ring constitutes most all of the section, and is composed of Haversian systems with many senile changes.

The internal circumferential lamellæ form a narrow fragmentary ring around the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF AN EAST INDIAN. NO. 223, CR. MED. COLL.

PL. 30, FIG. 386. SYN. TAB. X

Antero-posterior diameter of bone, 29 mm.; lateral, 24 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—External circumferential lamellæ surround the section. In the inner and anterior wall they are interrupted by crude Haversian systems of the (Ia) differentiation.

The central ring is composed of large, small, and irregularly shaped, well developed Haversian systems. Here and there a few, short, inter-Haversian lamellæ appear. Some of the systems are senile. But, on the whole, the Haversian systems are strong and well developed.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, Ia, C.

LEFT FEMUR OF AN EAST INDIAN. NO. 223, CR. MED. COLL.

PL. 30, FIG. 387. SYN. TAB. X

The leg had been amputated below the knee and the femur had not exercised its normal function for years.

Antero-posterior diameter of bone, 28 mm.; lateral, 22 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 49%.

Structure.—The section is surrounded by external circumferential lamellæ, thinnest in the anterior wall. The lamellæ are interrupted by crude Haversian systems of the (Ia) differentiation.

The central ring is composed of large, small, and irregularly shaped Haversian systems, showing senile changes which are most numerous around the medullary canal.

Internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, Ia, C, senile.

A comparison of the two foregoing femora shows that the femur of the amputated leg is smaller than the other, the index is higher, the wall of the bone is thinner, and senile changes are more marked.

RIGHT FEMUR OF A WHITE MALE, AGE 55. NO. 228479, U. S. NAT. MUS.

PL. 30, FIG. 388. SYN. TAB. X

Antero-posterior diameter of bone, 32 mm.; lateral, 28 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 17 mm.

The medullary canal is full. Medullary index, 36%. There is considerable cancellous bone.

Structure.—The external circumferential lamellæ are fragmentary and show the remains of the lamellar or laminar horseshoe.

The central ring constitutes almost the whole thickness of the walls and is composed of Haversian systems with some inter-Haversian lamellæ. The systems are large, small, and irregular, and show some senile changes. There are very few cross canals. Their lacunæ are oval and narrow.

The internal circumferential lamellæ form a narrow ring around the medullary canal and in the anterior wall assume the form of cancellous bone.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE, AGE 45. NO. 154, MED. DEPT. NORTHWESTERN UNIV.

PL. 30, FIG. 389. SYN. TAB. X

Antero-posterior diameter of bone, 30 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 26%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring is composed of Haversian systems, which, in the inner wall, alternate with concentric laminæ. Many systems are senile.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 146, MED. DEPT. NORTHWESTERN UNIV.

PL. 30, FIG. 390. SYN. TAB. X

Antero-posterior diameter of bone, 28 mm.; lateral, 24 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 24%.

Structure.—The external circumferential lamellæ are fragmentary. Half systems frequently occur on the external border of the section. The central ring forms practically all of the bone and is composed of irregularly shaped Haversian systems. Senile changes are marked. The lacunæ are oval and long and the canaliculi are bushy and straight. The internal circumferential lamellæ are fragmentary.

Type III, C, senile.

LEFT FEMUR OF A WHITE MALE, AGE 60. NO. 159, MED. DEPT. NORTHWESTERN UNIV.

PL. 30, FIG. 391. SYN. TAB. X

Antero-posterior diameter of bone, 32 mm.; lateral, 31.5 mm.

Antero-posterior diameter of medullary canal, 17.5 mm.; lateral, 18 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring is composed of Haversian systems showing many senile changes.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 167, MED. DEPT. NORTHWESTERN UNIV.

PL. 30, FIG. 392. SYN. TAB. X

Antero-posterior diameter of bone, 27 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 30%.

Structure.—The external circumferential lamellæ are fragmentary. For the most part, Haversian systems form the external boundary of the section. The central ring is composed of Haversian systems and inter-Haversian lamellæ in the inner wall and of Haversian systems elsewhere. The internal circumferential lamellæ are fragmentary.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 172, MED. DEPT. NORTHWESTERN UNIV.

PL. 30, FIG. 393. SYN. TAB. X

Antero-posterior diameter of bone, 32 mm.; lateral, 31.5 mm.

Antero-posterior diameter of medullary canal, 17.5 mm.; lateral, 18 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—A narrow band of external circumferential lamellæ, somewhat fragmentary, forms the external boundary of the section. The central ring is composed of Haversian systems, well developed and of varying sizes. In the anterior and inner wall, the systems are separated by a little inter-Haversian structure. Many senile systems appear. Few cross canals are seen. The internal circumferential lamellæ are fragmentary.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 242, CR. MED. COLL.

PL. 31, FIG. 394. SYN. TAB. X

Antero-posterior diameter of bone, 32 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 19 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 49%.

Structure.—The external circumferential lamellæ are fragmentary. Remains of the lamellar horseshoe are found in the inner wall.

The central ring forms nearly the whole of the section and is composed of Haversian systems, many of which show senile changes.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE, AGE 60. NO. 145, MED. DEPT. NORTHWESTERN UNIV.

PL. 31, FIG. 395. SYN. TAB. X

Antero-posterior diameter of bone, 30 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 18 mm.

The medullary canal is full. Medullary index, 49%.

Structure.—The external circumferential lamellæ are fragmentary and half systems occur on the external boundary of the section. The central ring is composed of well developed, large and small Haversian systems. Many senile changes occur in the anterior and posterior wall. Few cross canals are seen. The internal circumferential lamellæ form a narrow ring around the medullary canal and in the anterior and posterior wall cancellous bone.

Type III, C, senile.

LEFT FEMUR OF A WHITE FEMALE. NO. 174, MED. DEPT. NORTHWESTERN UNIV.

PL. 31, FIG. 396. SYN. TAB. X

Antero-posterior diameter of bone, 27 mm.; lateral, 26 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 13 mm.

The medullary canal is full. Medullary index, 35%.

Structure.—The external circumferential lamellæ surround the section. In the outer wall they form a wide background of about half the width of the wall in which are numerous Haversian systems. The background gradually disappears in the anterior wall and the lamellæ are reduced to a very narrow rim. In the inner wall the narrow rim gradually widens again as it approaches the posterior ridge. The central ring is composed of large and small Haversian systems, many of which are senile. Near the external surface of the posterior ridge groups of round and oval lacunæ appear between the systems. The internal circumferential lamellæ are fragmentary.

Type I-III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 157, MED. DEPT. NORTHWESTERN UNIV.

PL. 31, FIG. 397. SYN. TAB. X

Antero-posterior diameter of bone, 30 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 16.5 mm.; lateral, 16 mm.

The medullary canal is full. Medullary index, 44%.

Structure.—The external circumferential lamellæ, separated into laminæ in the lateral wall, surround the section. The central ring is composed of Haversian systems, and senile changes are abundant. In the inner wall may be seen distinct remains of the lamellar horseshoe. The internal circumferential lamellæ are fragmentary.

Type I-II-III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 161, MED. DEPT. NORTHWESTERN UNIV.

PL. 31, FIG. 398. SYN. TAB. X

Antero-posterior diameter of bone, 28 mm.; lateral, 31 mm.

Antero-posterior diameter of medullary canal, 12 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 26%.

Structure.—The external lamellæ are practically absent. The central ring is composed of various forms of Haversian systems with considerable inter-Haversian lamellæ, especially in the inner wall. This is the remains of the horseshoe. Many senile changes are present. Near the posterior ridge the systems are oval and assume a concentric arrangement. The internal lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 153, MED. DEPT. NORTHWESTERN UNIV.

PL. 31, FIG. 399. SYN. TAB. X

Antero-posterior diameter of bone, 27.5 mm.; lateral, 26 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 27%.

Structure.—A wide horseshoe band of lamellæ extends around the external border of the section and is interrupted by numerous crude Haversian systems of the (Ia) differentiation and crossed by canals. The central ring is composed of large, small, and irregular Haversian systems, some of which are senile. The internal lamellæ form a broken ring around the medullary canal.

Type I-III, Ia, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 243, CR. MED. COLL.

PL. 31, FIG. 400. SYN. TAB. X

Antero-posterior diameter of bone, 30 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 23%.

Structure.—The section is surrounded for the most part by a wide horseshoe band of lamellæ, interrupted frequently by Haversian systems of the (Ia) differentiation.

The central ring is composed of Haversian systems with fragments of lamellæ running between them in all directions. This is especially true in the outer wall. A few senile systems appear. Internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-III, Ia, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 148, MED. DEPT. NORTHWESTERN UNIV.

PL. 31, FIG. 401. SYN. TAB. X

Antero-posterior diameter of bone, 24 mm.; lateral, 33 mm.

Antero-posterior diameter of medullary canal, 13.5 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 30%.

Structure.—Remains of the lamellar horseshoe band are seen as a background in the lateral and anterior wall. The band is interrupted by numerous Haversian systems. The central ring is incomplete and composed of large, small, and irregular Haversian systems. Senile changes are frequent in the anterior and posterior wall. The internal lamellæ form a narrow ring around the medullary canal.

Type I-III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 230, CR. MED. COLL.

PL. 31, FIG. 402. SYN. TAB. X

Antero-posterior diameter of bone, 31 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 33%.

Structure.—The horseshoe band of lamellæ, widest in the outer and absent in the anterior wall, remains as a background. It forms half of the outer and one-third of the posterior inner wall. In the lamellar background are oval and round Haversian systems. The central ring is composed of large, small, and irregular Haversian systems. Senile changes are frequent. The lacunæ are generally oval. The internal circumferential lamellæ appear in fragments and as cancellous bone in the anterior wall.

Type I-III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 97, CR. MED. COLL.

PL. 32, FIG. 403. SYN. TAB. X

Antero-posterior diameter of bone, 28.5 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 45%.

Structure.—A wide horseshoe band of laminæ and lamellæ surrounds the section. On both sides of the ridge the heel of the shoe constitutes nearly the whole thickness of the wall, while the toe constitutes more than one-half of the anterior wall. In the inner wall the band is narrow and in the outer wall, wide. On both sides of the posterior ridge the heel of the shoe is composed of laminæ with inter-laminar Haversian systems and canals. The laminæ merge together to some extent as they reach the anterior wall, but are still evident in that region. The Haversian systems of the horseshoe band are of the (Ia) and (C) differentiations, the former predominating. Their locations between adjacent laminæ produce irregular borders of the laminæ. In the anterior wall the systems are all poorly developed, being little more than Haversian canals. The lacunæ of the lamellæ are long and narrow; of the laminæ, somewhat oval.

The central ring is narrow and composed of well developed Haversian systems in the outer, a wide band of lamellæ and Haversian systems in the anterior, lamellæ and Haversian systems in the inner wall, and Haversian systems in the posterior ridge. No senile changes appear. The posterior ridge is composed of Haversian systems and inter-Haversian lamellæ with many oval lacunæ. The internal circumferential lamellæ form an irregular ring of varying widths around the medullary canal. The bone is more than one-half laminæ and lamellæ.

Type I-II-III, Ia, C.

LEFT FEMUR OF A WHITE MALE. NO. 99, CR. MED. COLL.

PL. 32, FIG. 404. SYN. TAB. X

Antero-posterior diameter of bone, 30 mm.; lateral, 27.5 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 20%.

Structure.—Beginning on the outer side of the posterior ridge and extending around the lateral wall are coarse laminæ, interrupted by a few Haversian systems of the (C) differentiation and by many of the (Ia) differentiation. As the laminæ reach the anterior wall they merge into lamellæ, which terminate in the anterior inner wall, and are then completely displaced by well developed Haversian systems. The laminæ again appear in the posterior wall. The lacunæ are generally oval and their canaliculi straight. In the outer wall is a wide semicircular area of laminæ, which, with those of the external band, constitute the whole wall. These laminæ are also interrupted by Haversian systems similar to those of the external band.

The central ring is incomplete, since it is limited to a narrow portion of the anterior, nearly the whole of the inner anterior and posterior wall. It is composed of well developed Haversian systems without senile changes.

The medullary canal is surrounded by laminæ, interrupted by Haversian systems of the (Ia) differentiation. The section is more than half lamellæ and laminæ.

Type I-II-III, Ia, C.

RIGHT FEMUR OF A WHITE MALE. NO. 160, MED. DEPT. NORTHWESTERN UNIV.

PL. 32, FIG. 405. SYN. TAB. X

Antero-posterior diameter of bone, 28 mm.; lateral, 28.5 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—Beginning on the inner side of the posterior ridge and extending around the inner and a part of the anterior wall is a wide band of lamellæ in which are many well developed Haversian systems. The band forms the entire thickness of the inner posterior wall. In the anterior outer wall the band has been displaced by Haversian systems, and in the outer posterior wall the lamellar band again appears.

The central ring is composed of Haversian systems of the (C) differentiation, many of which show senile changes.

The internal circumferential lamellæ are fragmentary. The section is about half lamellæ.

Type I-III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 163, MED. DEPT. NORTHWESTERN UNIV.

PL. 32, FIG. 406. SYN. TAB. X

Antero-posterior diameter of bone, 28 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 11.5 mm.

The medullary canal is full. Medullary index, 32%.

Structure.—Beginning on the inner side of the posterior ridge and extending around the external border of the inner and anterior wall is a wide band of lamellæ, interrupted by Haversian systems. The band forms about half of the inner and the whole of the anterior wall, and is then displaced by Haversian systems. The lacunæ are oval and long. Around the external surface of the outer wall is a narrower band of lamellæ, interrupted by canals of the (Ia) differentiation. The central ring of the inner and outer wall is composed of Haversian systems, some of which exhibit senile changes. In the posterior ridge the systems are separated by lamellæ with oval lacunæ. The medullary canal is enclosed by a narrow ring of lamellæ.

Type I-III, Ia, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 156, MED. DEPT. NORTHWESTERN UNIV.

PL. 32, FIG. 407. SYN. TAB. X

Antero-posterior diameter of bone, 31 mm.; lateral, 23.5 mm.

Antero-posterior diameter of medullary canal, 11 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 20%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring constitutes nearly all of the section and is composed of large, small, and irregularly shaped Haversian systems in a wide band of lamellæ, especially in the inner and posterior wall. The band is nearly displaced by Haversian systems in the outer wall. Senile changes are frequent. The internal circumferential lamellæ are fragmentary. The section shows an unusually large, inner posterior ridge.

Type I-III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 169, MED. DEPT. NORTHWESTERN UNIV.

PL. 32, FIG. 408. SYN. TAB. X

Antero-posterior diameter of bone, 31 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 37%.

Structure.—Beginning on the inner side of the posterior ridge and extending around the inner lateral wall is a wide lamellar background in which are numerous Haversian systems. In the anterior wall the band narrows to an interrupted rim and widens again to a background in the outer wall.

The central ring is composed of Haversian systems, large and small, with some senile changes. Along the external surface of the posterior ridge the systems are separated by lamellæ with oval and round lacunæ. The internal circumferential lamellæ form a narrow ring around the medullary canal. Senile changes are numerous in the systems in close proximity to the medullary canal.

Type I-III, C, senile.

RIGHT FEMUR OF A WHITE MALE, AGE 35. NO. 151, MED. DEPT. NORTHWESTERN UNIV.

PL. 32, FIG. 409. SYN. TAB. X

Antero-posterior diameter of bone, 28 mm.; lateral, 31 mm.

Antero-posterior diameter of medullary canal, 11.5 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 19%.

Structure.—The external circumferential lamellæ surround the bone. They form thin bands in the lateral wall and are displaced by bone substance with large oval lacunæ and bushy canaliculi in the posterior ridge. The anterior wall is over half lamellæ, in which are parallel rows of crude Haversian systems of the (Ia) differentiation, arranged concentrically. The lamellæ and systems form the external part of the wall, and, as they approach and pass into the lateral wall, they are replaced by wide bands of irregularly shaped Haversian systems. Senile changes are frequent in the inner lateral wall. Underneath the lamellar and Haversian system band is a central ring of regular Haversian systems, well developed.

The internal circumferential lamellæ form a wide band in the lateral and posterior wall. In the posterior, outer lateral wall several laminæ extend obliquely from the interior of the wall to the medullary surface. The external half of the posterior ridge is composed of Haversian systems, between which is bone substance with many oval lacunæ, while the medullary half is composed of Haversian systems with a little inter-Haversian lamellæ.

Type I-II-III, Ia, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 100, CR. MED. COLL.

PL. 32, FIG. 410. SYN. TAB. X

Antero-posterior diameter of bone, 24 mm.; lateral, 31 mm.

Antero-posterior diameter of medullary canal, 17.5 mm.; lateral, 13.5 mm.

The medullary canal is full. Medullary index, 46%.

Structure.—The external circumferential lamellæ form the boundary of a part of the outer wall. In some places, however, Haversian systems form the external boundary. In the outer wall laminæ separate the Haversian systems of the central ring. Their lacunæ are well developed.

The central ring constitutes the greater part of the section, and especially is this true of the outer wall.

In the inner wall is a wide external band of laminæ and oblong Haversian systems extending from the posterior ridge around to the outer antero-lateral junction. In the anterior wall is a wide band of lamellæ. The systems are large, small, and irregular in shape. In those around the medullary canal, senile changes appear. The internal circumferential lamellæ form an extremely narrow ring around the medullary canal.

Type I-II-III, C, senile.

RIGHT FEMUR OF A WHITE FEMALE. NO. 150, MED. DEPT. NORTHWESTERN UNIV.

PL. 32, FIG. 411. SYN. TAB. X

Antero-posterior diameter of bone, 26 mm.; lateral, 26 mm.

Antero-posterior diameter of medullary canal, 20 mm.; lateral, 21 mm.

The medullary canal is full. Medullary index, 16%.

Structure.—The section is irregular in shape and is composed of a background of lamellæ, in which are irregularly shaped Haversian systems with senile changes.

Type I-III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 152, MED. DEPT. NORTHWESTERN UNIV.

PL. 33, FIG. 412. SYN. TAB. XI

Antero-posterior diameter of bone, 26 mm.; lateral, 37 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 16 mm.

The medullary canal is full. Medullary index, 30%.

Structure.—The section is the first portion of a double femur. The original femur (fig. 412B) is composed of Haversian systems almost entirely. In the posterior wall they are separated by short lamellæ with oval lacunæ. Many senile changes occur. In some systems the Haversian canals have increased in diameter to such an extent that only a narrow rim of bone remains. Around the medullary canal are large spaces. The lacunæ of the systems are of the oval type and not very numerous. The external and internal circumferential lamellæ appear in fragments. Between the original and accessory growth is a concentric series of spaces partly surrounded by enclosing lamellæ. A sharp line appears between the two bones (fig. 412C). The accessory bone is composed of a background of lamellæ in which are Haversian systems of the (Ib) differentiation and numerous radiating canals. The inter-Haversian lamellæ with oval lacunæ predominate. Many of the systems are senile. The external circumferential lamellæ are fragmentary. The accessory portion shows an earlier development than the original bone by its predominating lamellæ and relatively few Haversian systems.

Type I-III, Ib, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 152, MED. DEPT. NORTHWESTERN UNIV.

PL. 33, FIG. 413. SYN. TAB. XI

Antero-posterior diameter of original bone, 27 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal of original bone, 16 mm.; lateral, 17 mm.

The medullary canal is full. Medullary index, 67%.

Antero-posterior diameter of accessory bone, 23 mm.; lateral, 18 mm.

Antero-posterior diameter of accessory medullary canal, 10 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 31%.

Antero-posterior diameter of the whole bone, 25 mm.; lateral, 45 mm.

The section was taken 33 mm. below figure 412.

Structure.—In this section the accessory development has formed an additional femur. The original bone is composed of Haversian systems for the most part, but their senile changes are markedly increased (fig. 413B). The accessory bone is composed of lamellæ with oval lacunæ, interrupted by numerous Haversian systems of the (Ib) differentiation. The two bones are separated by a narrow partition of cancellous bone (fig. 413C). Internal and external circumferential lamellæ in both bones are fragmentary.

Type I-III, Ib, C, senile.

LEFT FEMUR OF A WHITE FEMALE. NO. 164, MED. DEPT. NORTHWESTERN UNIV.

PL. 33, FIG. 414. SYN. TAB. XI

Antero-posterior diameter of bone, 28 mm.; lateral, 27.5 mm.

Antero-posterior diameter of medullary canal, 20 mm.; lateral, 20 mm.

The medullary canal is full. Medullary index, 55%.

Structure.—The external circumferential lamellæ appear only in short fragments. The central ring is composed of large and small, irregularly shaped Haversian systems in a background of lamellæ which extends around the bone. The systems are generally senile. The wall of the bone is thin. The anterior and inner wall is nearly half destroyed by senile losses.

Internal circumferential lamellæ occur in fragments.

Type I-III, C, senile.

LEFT FEMUR OF A WHITE FEMALE. NO. 166, MED. DEPT. NORTHWESTERN UNIV.

PL. 33, FIG. 415. SYN. TAB. XI

Antero-posterior diameter of bone, 26.5 mm.; lateral, 26 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 13 mm.

The medullary canal is full. Medullary index, 34%.

Structure.—Beginning on both sides of the posterior ridge and extending around the lateral wall are two bands of lamellæ, incompletely separated into laminæ and interrupted by Haversian systems. The band disappears entirely in the anterior and antero-lateral wall. The external surface of the posterior ridge shows many large, oval lacunæ between the Haversian systems. The central ring is composed of Haversian systems, large and small, with considerable inter-Haversian lamellæ. The systems show many senile changes. The internal circumferential lamellæ are fragmentary.

Type I-III, C, senile.

RIGHT FEMUR OF A WHITE MALE (SUICIDE), AGE 22. NO. 175, CR. MED. COLL.

PL. 33, FIG. 416. SYN. TAB. XI

Antero-posterior diameter of bone, 27 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 19 mm.

The medullary canal is full. Medullary index, 53%.

Structure.—The section is surrounded by a band of lamellæ and laminæ. In the anterior and inner wall the band is lamellar and perforated by numerous canals of the (Ia) differentiation. In the outer and posterior wall the band is laminar and interrupted by elongated Haversian systems of the (Ib) formation.

The central ring is irregular. In the outer wall it is thick and composed of well developed Haversian systems; in the antero-inner lateral wall it is thin; and in the posterior inner lateral it is almost entirely absent.

Internal circumferential lamellæ form a narrow cancellous ring around the medullary canal. The lamellæ are separated into laminæ in the inner wall.

Type I-II-III, Ia, Ib, C.

LEFT FEMUR OF A WHITE MALE. NO. 98, CR. MED. COLL.

PL. 33, FIG. 417. SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 39%.

Structure.—External circumferential lamellæ and laminæ surround the section. In the inner wall are two rows of elongated Haversian systems extending in a concentric direction from the external laminæ to the medullary surface of the anterior wall. The central ring of Haversian systems constitutes almost the entire thickness of the wall of the bone. The inner wall shows the borders of a wide external crescent composed of very much flattened Haversian systems.

The Haversian systems are large, small, and irregular in shape. Nearly one-half of them in the outer and a few in the inner wall show senile changes. The various stages of senility are well marked in this bone. In the early stage the lamellæ of the Haversian systems are prominent. The organic portion of the lamellæ seems to separate from the inorganic and the mineral salts begin to appear as granules in the lamellæ around the Haversian canals. In this stage the systems appear brown with sharply defined lamellæ. In the next stage the mineral deposit is heavy and the systems are black. Here and there a system can be seen in the last stage. The lamellæ around the Haversian canal are absorbed and little by little the Haversian canal widens until a narrow black ring is all that remains of the system, or the entire system disappears. The inorganic salts are deposited in the Haversian canals (pl. 34, figs. 424-426). After this manner the bone becomes light and the walls become thin as the process extends outward from the medullary canal. The internal circumferential lamellæ appear in fragments.

Type I-II-III, C, senile.

LEFT FEMUR OF A WHITE MALE. NO. 91, CR. MED. COLL.

PL. 33, FIG. 418. SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 13 mm.

The medullary canal is full. Medullary index, 39%.

Structure.—External circumferential lamellæ surround the section, excepting the posterior ridge. The central ring is composed of Haversian systems with the remains of a laminar horseshoe in the posterior lateral wall. No senile changes are found.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-II-III, C.

FEMUR OF AN AUSTRALIAN. NO. 227420, U. S. NAT. MUS.

PL. 34, FIG. 419. SYN. TAB. XI

Antero-posterior diameter of bone, 28 mm.; lateral, 23 mm.

Antero-posterior diameter of medullary canal, 12 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 25%.

Structure.—The external circumferential lamellæ enclose the bone, excepting the anterior wall and posterior ridge. Beginning on either side of the posterior ridge and extending around the lateral to the anterior wall are two wide bands composed of lamellæ and elongated Haversian systems, arranged in concentric rows. Their long diameters are parallel to the external surface of the bone. As the bands approach the anterior wall they are displaced by Haversian systems, which form the whole width of the wall. These bands are the remains of the horseshoe.

The anterior wall and posterior ridge are composed entirely of Haversian systems. The lacunæ are oval and narrow. The internal circumferential lamellæ form a broken narrow ring around the medullary canal.

Type I-III, C.

LEFT FEMUR OF A WHITE MALE. NO. 94, CR. MED. COLL.

PL. 34, FIG. 420. SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—External circumferential lamellæ form a narrow ring around the section. Beginning on both sides of the posterior ridge and extending around the lateral wall are wide bands of elongated and well developed Haversian systems with considerable inter-Haversian lamellæ. As the band of the inner wall approaches the anterior it is entirely displaced by Haversian systems, while the band of the outer wall is displaced about the mid-lateral region. The central ring, therefore, is irregular in shape and position. It is composed of well developed Haversian systems.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-III, C.

RIGHT FEMUR OF A WHITE MALE, AGE 40. NO. 142, MED. DEPT. NORTHWESTERN UNIV.

PL. 34, FIG. 421. SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 27.5 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 11.5 mm.

The medullary canal is full. Medullary index, 22%.

Structure.—Beginning on both sides of the posterior ridge and extending around the section is an enclosing band of varying widths composed of lamellæ, interrupted by small Haversian systems of the (Ia) differentiation. The band is widest in the outer and anterior wall.

Underneath this band is a wide central ring of well developed Haversian systems. They vary in size and present some senile changes around the medullary canal.

The internal circumferential lamellæ form a narrow ring around the medullary canal. The bone units are well developed.

Type I-III, Ia, C, senile.

HAVERSIAN SYSTEMS SHOWING STAGES OF SENILITY

PL. 34, FIGS. 423-24-25-26

These systems were taken from figure 417 and enlarged. Figure 423 shows an Haversian system before senile changes are visible. It is composed of a number of concentric lamellæ with serrated edges united by cement. The lacunæ are long and narrow and are situated either between the lamellæ or within them. There does not seem to be any regularity in the arrangement.

Figure 424 shows an early stage of senility. In this Haversian system there is a deposit of opaque granules in the lamellæ around the Haversian canal. The density of the granules diminishes from the canal toward the periphery.

Figure 425 shows a later stage. The density has increased and expanded. The central lamellæ have dropped out and the Haversian canal is larger. The whole system is more or less involved. In the external portion the granules are brown and the lamellæ are somewhat dim. The central ring is black.

Figure 426 shows the last stage. The lamellæ have nearly all disappeared, and a narrow black ring only remains. The Haversian canal is large and irregular in shape. The medullary canal is very much increased in size and the bone is light in weight.

Senile changes are more frequent around the medullary canal than elsewhere, although they may occur in any part of the bone.

As the lamellæ around the Haversian canals become more and more opaque with inorganic salts they gradually disintegrate, the inorganic matter enters the blood vessels and is carried into the general circulation to be removed from the body or deposited in the degenerating wall of blood vessels.

RIGHT FEMUR OF A WHITE MALE (CONVICT). NO. 2, MED. DEPT. NEBRASKA UNIV.

PL. 35, FIG. 428. SYN. TAB. XI

Antero-posterior diameter of bone, 32 mm.; lateral, 27.5 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 21%.

Structure.—A narrow band of external circumferential lamellæ surrounds the section.

The central ring is composed of large, small, and variously shaped Haversian systems with relatively small Haversian canals. On account of the small canals the Haversian systems have thick walls. Many of the canals are situated eccentrically. Scattered throughout the wall of the section are many Haversian systems in various stages of senility. In some, the two or three lamellæ around the Haversian canal are involved; in others, half of the system is senile; and in others, the whole system is black with mineral precipitation. In the posterior inner wall a few elliptical Haversian systems occur.

Internal circumferential lamellæ surround the medullary canal. The lacunæ of the section are generally oval.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE (CONVICT). NO. 3, MED. DEPT. NEBRASKA UNIV.

PL. 35, FIG. 429. SYN. TAB. XI

Antero-posterior diameter of bone, 26.5 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 12 mm.

The medullary canal is full. Medullary index, 39%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring is composed of variously shaped, large and small Haversian systems with no inter-Haversian lamellæ. Some of the systems are well developed; some have small Haversian canals; some show early stages of senility; some later; and some the latest. The lacunæ are generally oval. A narrow ring of internal circumferential lamellæ surrounds the medullary canal.

Type III, C, senile.

* LEFT FEMUR OF A WHITE MALE, AGE 50. NO. 268, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 12 mm.

Medullary index, 21%.

Structure.—The external circumferential lamellæ are fragmentary. The section is composed almost entirely of small, large, and irregularly shaped Haversian systems and a small amount of inter-Haversian lamellæ. In the vicinity of the medullary canal many of the systems are senile. The internal circumferential lamellæ are fragmentary.

Type III, C, senile.

* RIGHT FEMUR OF A WHITE MALE. NO. 269, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 29 mm.; lateral, 33.5 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 20 mm.

Medullary index, 54%.

Structure.—A wide background of lamellæ, enclosing Haversian canals and small Haversian systems, forms the external half of the anterior wall and is mostly displaced by Haversian systems as it extends around the lateral wall to the posterior ridge. The systems vary in size and shape and many show senile changes. There is a scarcity of communicating cross canals.

In the inner wall a short, fan-shaped band of laminæ, interrupted by small Haversian systems, extends from the medullary surface of the posterior ridge outward. This has been observed in a number of femora, but not in all. Its significance is not clear.

The internal circumferential lamellæ form a very narrow fragmentary ring around the medullary canal.

Type I-II-III, Ia, C, senile.

* RIGHT FEMUR OF A WHITE MALE. NO. 270, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 31 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 13 mm.

Medullary index, 29%. The section is almost quadrangular in shape.

Structure.—The external circumferential lamellæ are fragmentary. The section is composed, for the most part, of well developed Haversian systems with very little inter-Haversian bone substance. Many of the systems are senile. The cross canals are fairly numerous.

The internal circumferential lamellæ form a very narrow ring around the medullary canal.

Type III, C, senile.

* RIGHT FEMUR OF A WHITE MALE. NO. 271, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 31 mm.; lateral, 32 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 15 mm.

Medullary index, 35%.

Structure.—The external circumferential lamellæ form a narrow ring around the bone.

The section is composed almost entirely of large, small, and irregularly shaped Haversian systems. Their lacunæ are generally oval. The cross canals are not numerous. Senile changes are few.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C.

* RIGHT FEMUR OF A WHITE MALE. NO. 272, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 33 mm.; lateral, 28 mm.

Antero-posterior diameter of medullary canal, 27 mm.; lateral, 25 mm.

Medullary index, 26%.

Structure.—The external circumferential lamellæ appear as rather wide bands on both sides of the posterior ridge. These bands are interrupted by small Haversian systems and become narrower as they approach the anterior wall where they are fragmentary. The remainder of the section is composed of Haversian systems with oval and long lacunæ.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C.

* RIGHT FEMUR OF A WHITE MALE. NO. 273, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 28 mm.; lateral, 29 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 12 mm.

Medullary index, 29%.

Structure.—The external circumferential lamellæ form a complete narrow ring around the bone. The section is composed of well developed Haversian systems closely packed together. Some are large, some small, and some are irregular. Senile changes are frequent.

The internal circumferential lamellæ enclose the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 274, CR. MED. COLL.

PL. 35, FIG. 436. SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 35 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 16 mm.

Medullary index, 30%.

Structure.—The external circumferential lamellæ are fragmentary. The rest of the section is composed almost entirely of Haversian systems, many of which are large in size and have large, irregularly shaped Haversian canals. They are more numerous around the medullary canal than elsewhere. They give to the section a general porous appearance when observed with the naked eye.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 275, CR. MED. COLL.

PL. 35, FIG. 437. SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 19 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 50%.

Structure.—The section is surrounded by a wide band of lamellæ, interrupted by numerous Haversian systems of the (Ia) and (C) differentiations. The central ring, about equal in width to the external lamellar band, is composed of well developed Haversian systems, many of which are senile.

A narrow ring of internal lamellæ surrounds the medullary canal.

Type I-III, Ia, C, senile.

* LEFT FEMUR OF A WHITE MALE. NO. 276, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 28 mm.; lateral, 33.5 mm.

Antero-posterior diameter of medullary canal, 26 mm.; lateral, 17.5 mm.

Medullary index, 100%.

Structure.—The external circumferential lamellæ form a narrow ring around the bone.

The section is composed of Haversian systems, which, in the anterior wall, are separated by the fragments of a lamellar horseshoe band described elsewhere. Many systems are senile.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 277, CR. MED. COLL.

PL. 35, FIG. 439. SYN. TAB. XI

Antero-posterior diameter of bone, 32 mm.; lateral, 28 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 11 mm.

The medullary canal is full. Medullary index, 28%.

Structure.—External circumferential lamellæ, interrupted by many Haversian systems, surround the section. The central ring, irregular in width, is composed of Haversian systems, somewhat irregular in shape, but well developed. The internal circumferential lamellæ, expanded into a wide semicircular area in the inner wall, surround the medullary canal.

Type I-III, C.

* RIGHT FEMUR OF A WHITE MALE. NO. 278, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 29 mm.; lateral, 34 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 15 mm.

Medullary index, 35%.

Structure.—The external circumferential lamellæ are fragmentary. The section is composed almost entirely of large, small, and irregularly shaped Haversian systems.

The internal circumferential lamellæ form a narrow enclosing ring around the medullary canal.

Type III, C.

* RIGHT FEMUR OF A WHITE MALE. NO. 279, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 14 mm.

Medullary index, 38%.

Structure.—The external circumferential lamellæ are fragmentary. The section is composed almost entirely of large, small, and irregular Haversian systems, between which are some areas of short lamellæ. The lacunæ are oval; senile changes are frequent. The internal circumferential lamellæ are fragmentary.

Type III, C, senile.

* RIGHT FEMUR OF A WHITE MALE. NO. 280, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 24.5 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 11 mm.

Medullary index, 29%.

Structure.—The external circumferential lamellæ form a narrow ring around the bone. The section is mostly composed of well developed Haversian systems with little inter-Haversian bone substance.

The internal circumferential lamellæ surround the medullary canal.

Type III, C.

* LEFT FEMUR OF A WHITE MALE. NO. 281, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 31 mm.; lateral, 27 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 10 mm.

Medullary index, 19%.

Structure.—The external circumferential lamellæ are fragmentary. The section is composed of large, small, and irregularly shaped Haversian systems, some of which show senile changes.

The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type III, C, senile.

* RIGHT FEMUR OF A WHITE MALE. NO. 282, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 31.5 mm.

Antero-posterior diameter of medullary canal, 16 mm.; lateral, 13.5 mm.

Medullary index, 30%.

Structure.—The external circumferential lamellæ are fragmentary. The section is composed of well developed, closely arranged Haversian systems. As a rule, they are clearly distinct, but some of them are senile and obscure.

The internal circumferential lamellæ are fragmentary.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 284, CR. MED. COLL.

PL. 35, FIG. 445. SYN. TAB. XI

Antero-posterior diameter of bone, 26.5 mm.; lateral, 26 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 12.5 mm.

The medullary canal is full. Medullary index, 31%.

Structure.—Beginning on both sides of the posterior ridge and surrounding the section is a wide horseshoe of crude laminæ and lamellæ, frequently interrupted by Haversian systems of the (Ia) and (C) differentiations. The horseshoe forms half of the outer, nearly all of the anterior, and a third of the inner wall. The Haversian systems have, generally, concentric positions. The canals separating the laminæ are short. In the inner posterior wall is a fan-shaped area of laminæ, interrupted by a few Haversian systems. The remainder of the central ring, of which the fan is a part, is composed of Haversian systems with some senile changes. In the outer wall it has some inter-Haversian lamellæ. The posterior ridge is composed of Haversian systems.

A narrow ring of internal circumferential lamellæ surrounds the medullary canal.

Type I-II-III, Ia, C, senile.

This femur is characterized by units of low differentiations. Only a small portion of it is composed of well developed Haversian systems.

* RIGHT FEMUR OF A WHITE MALE. NO. 285, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 29 mm.; lateral, 28 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 35%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring constitutes nearly all of the section and is composed of Haversian systems with some inter-Haversian lamellæ. Many senile changes occur around the medullary canal. Internal circumferential lamellæ surround the medullary canal.

Type III, C, senile.

* RIGHT FEMUR OF A WHITE MALE. NO. 286, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 32 mm.; lateral, 27.5 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 14 mm.

The medullary canal is full. Medullary index, 36%.

Structure.—The external circumferential lamellæ are fragmentary. The central ring constitutes nearly all of the section and is composed of Haversian systems exhibiting many senile changes.

Internal circumferential lamellæ surround the medullary canal.

Type III, C, senile.

* RIGHT FEMUR OF A WHITE MALE. NO. 287, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 25 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 12 mm.; lateral, 9 mm.

The medullary canal is full. Medullary index, 21%.

Structure.—Around the outer and anterior wall is a wide band of lamellæ, interrupted by Haversian systems of the (Ia) differentiation. The band is displaced in the inner wall by Haversian systems. The central ring constitutes all of the inner wall, the posterior ridge, two-thirds of the outer and one-third of the anterior wall. It is composed of Haversian systems of the (C) differentiation, large and small, separated in the outer wall by wide inter-Haversian lamellæ. Some senile changes occur. The internal circumferential lamellæ form a narrow ring around the medullary canal.

Type I-III, Ia, C, senile.

* RIGHT FEMUR OF A WHITE MALE. NO. 288, CR. MED. COLL.

SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 31 mm.

Antero-posterior diameter of medullary canal, 17 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 38%.

Structure.—A narrow ring of external circumferential lamellæ surrounds the section.

The central ring constitutes nearly all of the bone and is composed of Haversian systems, many of which are senile. The systems are united by cross canals.

A narrow ring of internal circumferential lamellæ surrounds the medullary canal.

Type III, C, senile.

RIGHT FEMUR OF A WHITE MALE. NO. 289, CR. MED. COLL.

PL. 35, FIG. 451. SYN. TAB. XI

Antero-posterior diameter of bone, 30 mm.; lateral, 33 mm.

Antero-posterior diameter of medullary canal, 14 mm.; lateral, 15 mm.

The medullary canal is full. Medullary index, 27%.

Structure.—The external circumferential lamellæ, separated into short laminæ and interrupted by many Haversian systems, surround the section. The central ring blends with the external and internal rings and is composed of Haversian systems and lamellæ.

The internal circumferential lamellæ, expanding into a semicircular laminar area in the inner wall, surround the medullary canal.

Type I-II-III, C.

LEFT FEMUR OF A WHITE MALE. NO. 296, CR. MED. COLL.

PL. 35, FIG. 452. SYN. TAB. XI

Antero-posterior diameter of bone, 27.5 mm.; lateral, 23 mm.

Antero-posterior diameter of medullary canal, 12 mm.; lateral, 10 mm.

The medullary canal is full. Medullary index, 23%.

Structure.—A horseshoe band of lamellæ, frequently interrupted by complete and crude Haversian systems of the (Ia) differentiation, surrounds the section. It is widest in the anterior wall. The lacunæ are round, oval, long, and narrow.

The central ring, irregular in shape, is composed of well developed Haversian systems and forms the entire thickness of the posterior wall. The lacunæ are oval. The systems are united by many cross canals.

Internal circumferential lamellæ form a narrow ring around the medullary canal with the exception of the posterior wall. In the anterior wall it becomes cancellous.

Type I-III, Ia, C.

LEFT FEMUR OF A WHITE MALE, AGE 40. NO. 1, NEBRASKA STATE HOSPITAL

PL. 35, FIG. 453. SYN. TAB. XI

Case of idiopathic epilepsy. Patient had 20 convulsions the day of his death.

Antero-posterior diameter of bone, 27 mm.; lateral, 22 mm.

Antero-posterior diameter of medullary canal, 24 mm.; lateral, 18 mm.

Medullary index, 277%.

General character of the bone.—The femur was small in size. With the exception of a surrounding shell of bone from 1 mm. to 2 mm. thick, the entire medullary portion had suffered an extensive softening and the bone structure had disappeared.

Structure.—The external circumferential lamellæ were fragmentary. Quite large canals penetrated the bone from the periosteum.

The central ring was composed of large, small, and irregularly shaped Haversian systems and inter-Haversian lamellæ. In some systems the Haversian canals were very large and irregular, and in the others they were normal in size. The lacunæ were oval. In some portions of the section, large, irregularly shaped spaces were present. The internal circumferential lamellæ formed a narrow ring around the medullary canal.

Type III, C.

XVI. HISTOLOGICAL EXAMINATION OF TWO ENTIRE HUMAN FEMORA

1. Left Femur, 41 Cm. Long, No. 300, Cr. Med. Coll.

This bone was cut into pieces 2.5 cm. in length, and a cross-section of each piece was examined microscopically. The first section was made through the equatorial diameter of the head, the second through the middle of the neck, the third through the lesser trochanter, and the following sections through the shaft and lower extremity.

HEAD

This section was a circle with a diameter of 44 mm. It was surrounded by an enclosing envelope of bone 0.5 mm. in thickness and composed of lamellæ with round and oval lacunæ and rather infrequent canaliculi.

The remainder of the section was made up of cancellous bone, the meshes of which were filled with marrow. In the central portion of the section the cancellous bone was much heavier than elsewhere. The walls of the meshes were composed of lamellæ with oval and long lacunæ and radiated from the center toward the periphery. No Haversian systems were found.

NECK

Antero-posterior diameter of bone, 33 mm.; lateral, 27 mm.

This section was surrounded by an envelope of bone, varying in thickness from 1 mm. in the anterior to 3 mm. in the posterior wall. It was composed of lamellæ with oval lacunæ and bushy canaliculi, interrupted by a few Haversian systems.

The remainder of the section was made up of cancellous bone, heavier in the posterior than it was in the anterior wall, and having a radiating direction from the posterior toward the anterior boundary of the section. The cancellous bone, as a whole, was considerably denser than it was in the head and was composed of lamellæ, interrupted by a few crude Haversian systems.

SECTION THROUGH THE LESSER TROCHANTER

Antero-posterior diameter of bone, 37 mm.; lateral, 28 mm.

This section is surrounded by an envelope of bone, ranging in thickness from 1 mm. in the posterior to 4 mm. in the outer, 2.5 mm. in the anterior and 5 mm. in the inner wall.

From the inner wall the calcar femorale, an extension inward of the surrounding envelope, gradually separated into cancellous bone which then merged into that occupying the whole central portion of the section.

Structure.—The envelope was composed of indistinctly lamellated bone with diffusely arranged lacunæ and bushy canaliculi, interrupted by crude Haversian systems. The walls of the cancellous meshes were composed of lamellæ without Haversian systems.

FOURTH SECTION

Antero-posterior diameter of bone, 33 mm.; lateral, 28 mm.

Antero-posterior diameter of medullary canal, 19 mm.; lateral, 19 mm.

Medullary index, 67%.

Structure.—With the exception of the posterior ridge this section was surrounded by a wide horseshoe-shaped background of lamellæ, forming half of the thickness of the entire wall of the bone, and containing many Haversian systems of the (Ia) and (C) differentiations.

The posterior ridge was composed of Haversian systems, between which were lamellæ with many large, oval lacunæ and bushy canaliculi. The central ring was narrow and composed of Haversian systems with some inter-Haversian lamellæ. Many of the Haversian systems were senile. A narrow ring of internal circumferential lamellæ surrounded the medullary canal.

FIFTH SECTION

Antero-posterior diameter of bone, 31 mm.; lateral, 31 mm.

Antero-posterior diameter of medullary canal, 15 mm.; lateral, 14 mm.

Medullary index, 28%.

SIXTH SECTION

Antero-posterior diameter of bone, 28 mm.; lateral, 26 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 10 mm.

Medullary index, 22%.

SEVENTH SECTION

Antero-posterior diameter of bone, 28 mm.; lateral, 25 mm.

Antero-posterior diameter of medullary canal, 13 mm.; lateral, 10 mm.

Medullary index, 23%.

EIGHTH SECTION

Antero-posterior diameter of bone, 28 mm.; lateral, 26 mm.
Antero-posterior diameter of medullary canal, 13 mm.; lateral, 12 mm.
Medullary index, 27%.

NINTH SECTION

Antero-posterior diameter of bone, 28 mm.; lateral, 26 mm.
Antero-posterior diameter of medullary canal, 15 mm.; lateral, 14 mm.
Medullary index, 36%.

TENTH SECTION

Antero-posterior diameter of bone, 28 mm.; lateral, 27 mm.
Antero-posterior diameter of medullary canal, 17 mm.; lateral, 17 mm.
Medullary index, 62%.

ELEVENTH SECTION

Antero-posterior diameter of bone, 30 mm.; lateral, 28 mm.
Antero-posterior diameter of medullary canal, 21 mm.; lateral, 20 mm.
Medullary index, 100%.

TWELFTH SECTION

Antero-posterior diameter of bone, 31 mm.; lateral, 28 mm.
Antero-posterior diameter of medullary canal, 24 mm.; lateral, 21 mm.
Medullary index, 140%.

Structure.—The above sections resembled in structure the fourth, a description of which is already given. There was, however, an increasing proportion of the lamellar background from the fourth to the twelfth section. Senile systems were numerous.

THIRTEENTH SECTION

Antero-posterior diameter of bone, 34 mm.; lateral, 30 mm.

Structure.—The section is surrounded by a wide lamellar background in which are variously shaped Haversian systems. The remainder of the section is cancellous.

FOURTEENTH SECTION

Antero-posterior diameter of bone, 30 mm.; lateral, 40 mm.

Structure.—The section is surrounded by lamellæ with a few Haversian systems. The remainder of the section is cancellous.

FIFTEENTH SECTION

Antero-posterior diameter of bone, 31 mm.; lateral, 52 mm.

Structure.—The section is surrounded by lamellæ with a few Haversian systems. The remainder is cancellous.

The type of bone of this femur was I-III, C, senile. The characteristic units of structure were lamellæ.

2. Left Femur of a White Female, 38 Cm. Long. No. 301, Cr. Med. Coll.

Transverse sections were made at intervals of 2.5 cm. and in the same situations as they were in femur No. 300.

HEAD

Antero-posterior diameter of the equatorial section, 41 mm.; lateral, 41 mm.

Structure.—The section was surrounded by a thin envelope of bone, 0.5 mm. in thickness, and composed of lamellæ with a few very crude Haversian systems. The remainder of the section was made up of cancellous bone much more dense in the central portion than elsewhere and composed of lamellæ. The walls of the meshes radiated from the central portion toward the periphery.

NECK

Antero-posterior diameter, 30 mm.; lateral, 27 mm.

Structure.—The section was surrounded by an envelope of bone, varying in thickness from 3 mm. in the posterior to 1 mm. in the lateral wall. The enclosing envelope was composed of Haversian systems and some inter-Haversian lamellæ. The remainder of the section was made up of cancellous bone, denser near the posterior wall, and radiating from this location toward the periphery. It was considerably heavier than that of the head, and the walls of the meshes were composed of lamellæ with a few Haversian systems.

SECTION THROUGH THE LESSER TROCHANTER

Antero-posterior diameter, 34 mm.; lateral, 33 mm.

Structure.—The section was surrounded by an envelope of bone, varying in thickness from 4 mm. in the posterior to 1 mm. in the lateral wall. It was composed chiefly of Haversian systems, between which were some inter-Haversian lamellæ. The calcar femorale was well marked and composed of lamellæ with many Haversian systems. The remainder of the section was made up of a heavy cancellous bone composed of lamellæ.

FOURTH SECTION

Antero-posterior diameter of bone, 30 mm.; lateral, 27 mm.
Antero-posterior diameter of medullary canal, 22 mm.; lateral, 18 mm.
Medullary index, 97%.

FIFTH SECTION

Antero-posterior diameter of bone, 29 mm.; lateral, 25 mm.
Antero-posterior diameter of medullary canal, 20 mm.; lateral, 15 mm.
Medullary index, 72%.

SIXTH SECTION

Antero-posterior diameter of bone, 27 mm.; lateral, 24 mm.
Antero-posterior diameter of medullary canal, 18 mm.; lateral, 13 mm.
Medullary index, 58%.

SEVENTH SECTION

Antero-posterior diameter of bone, 26 mm.; lateral, 24 mm.
Antero-posterior diameter of medullary canal, 16 mm.; lateral, 13 mm.
Medullary index, 50%.

EIGHTH SECTION

Antero-posterior diameter of bone, 27 mm.; lateral, 24 mm.
Antero-posterior diameter of medullary canal, 17 mm.; lateral, 13 mm.
Medullary index, 87%.

As the foregoing five sections have practically the same minute structure one description will be sufficient for all.

Structure.—These sections were composed of small and large Haversian systems with a small amount of inter-Haversian lamellæ. Some of the systems are senile. The external and internal circumferential lamellæ were fragmentary. The cancellous bone disappeared at the seventh section.

NINTH SECTION

Antero-posterior diameter of bone, 27 mm.; lateral, 25 mm.
Antero-posterior diameter of medullary canal, 17 mm.; lateral, 15 mm.
Medullary index, 61%.

TENTH SECTION

Antero-posterior diameter of bone, 27 mm.; lateral, 25 mm.
Antero-posterior diameter of medullary canal, 18 mm.; lateral, 16 mm.
Medullary index, 75%.

ELEVENTH SECTION

Antero-posterior diameter of bone, 32 mm.; lateral, 30 mm.

Antero-posterior diameter of medullary canal, 26 mm.; lateral, 21 mm.

Medullary index, 69%.

Structure of the ninth, tenth, and eleventh sections.—With the exception of the posterior ridges these sections were composed of an external horseshoe-shaped band of lamellæ, which was wide in the anterior and very narrow in the lateral wall. The lamellar band was frequently interrupted by Haversian systems, some of which were senile. The central ring was composed of well developed, small and large Haversian systems, some of which were senile. The internal circumferential lamellæ were fragmentary.

The principal variations in these sections were seen in the appearance of the band of lamellæ and reappearance of the cancellous bone.

TWELFTH SECTION

Antero-posterior diameter of bone, 33 mm.; lateral, 28 mm.

Antero-posterior diameter of medullary canal, 20 mm.; lateral, 19 mm.

Medullary index, 126%.

THIRTEENTH SECTION

Antero-posterior diameter of bone, 27 mm.; lateral, 36 mm.

Cancellous.

FOURTEENTH SECTION

Antero-posterior diameter of bone, 28 mm.; lateral, 44 mm.

Cancellous.

FIFTEENTH SECTION

Antero-posterior diameter of bone, 35 mm.; lateral, 70 mm.

Cancellous.

Structure of twelfth, thirteenth, fourteenth, and fifteenth sections.—These were composed of Haversian systems and some inter-Haversian lamellæ. The band of lamellæ was not present. The systems were small and large, and some were senile. The external circumferential lamellæ were fragmentary and the internal were cancellous.

The type was III, C, senile.

SYNOPTIC TABLE I

Class		Right or left femur	Types and type combinations: I	II	III: Incomplete differentiation: Ia	Ib	Ic	III: Complete differentiation: C	Measurements: Bone: Ant.-post. diam. in mm.	Bone: Lat. diam. in mm.	Medullary canal: Ant.-post. diam. in mm.	Medullary canal: Lat. diam. in mm.	Medullary indices Per cent	Medullary canal: Full	Empty	Special	Senility	Reference: Figure	Plate
Amphibians.	Rana catesbiana (large bull frog) .... C. M. C.	R	×	..	..	..	..	..	3.5	4.5	1	2	16	×	..	......	..	1	1
	Rana catesbiana (medium bull frog) .... "	"	×	..	..	..	..	..	2.5	3	1.4	1.6	42	×	..	......	..	2	1
	Rana catesbiana (small bull frog) .... "	"	×	..	..	..	..	..	1	1.3	0.5	0.6	29	×	..	......	..	3	1
	Rana catesbiana (small bull frog) .... "	"	×	..	..	..	..	..	1	1.5	0.5	0.6	24	×	..	......	..	4	1
	Rana catesbiana (small, fractured and repaired) "	..	×	..	..	..	..	..	1.5	1.7	0.6	0.7	20	×	..	......	..	5	1
	Amblystoma tigrinum (most prim. amphib.) A. M. N. H.	R	×	..	..	..	..	..	2	2.5	0	0	0	×	..	cancellous	..	6	2
	Hyla versicolor (tree frog) .... U. S. N. M.	"	×	..	..	..	..	..	0.8	0.8	0.2	0.2	7	×	..	......	..	7	2
	Hyla arenicolor .... E. 50.30 "	"	×	..	..	..	..	..	0.5	0.5	0.2	0.2	19	×	..	......	..	8	2
	Hyla femoralis .... E. 60.23 "	"	×	..	..	..	..	..	0.5	0.4	0.2	0.2	24	×	..	......	..	9	2
	Hyla evittata .... E. 55.17 "	"	×	..	..	..	..	..	0.5	0.2	0.4	0.1	104	×	..	......	..	10	2
	Hyla cinerea .... E. 130.95 "	"	×	..	..	..	..	..	1.5	1	0.5	0.4	14	×	..	......	..	11	2
	Hyla regilla .... E. 62.39 "	"	×	..	..	..	..	..	1	0.9	0.5	0.5	38	×	..	......	..	12	2
	Hyla squirella .... E. 51.2 "	"	×	..	..	..	..	..	0.8	0.5	0.5	0.4	92	×	..	......	..	13	2
	Hyla gratiosa .... E. 40.14 "	"	×	×	..	..	..	..	1	0.8	0.5	0.5	44	×	..	......	..	14	2
	Dendrobates tinctorius .... E. 14.36 "	"	×	..	..	..	..	..	0.6	0.5	0.2	0.2	15	×	..	......	..	15	2
	Leptodactylus albilabris .... G. 13.11 "	"	×	..	..	..	..	..	1	0.8	0.8	0.3	59	×	..	......	..	16	2
	Chorophilus feriarum .... E. 52.47 "	"	×	..	..	..	..	..	0.5	0.4	0.2	0.2	24	×	..	......	..	17	2
	Acris gryllus .... "	"	×	..	..	..	..	..	0.5	0.3	0.2	0.1	16	×	..	......	..	18	2
	Rana catesbiana .... A. M. N. H.	"	×	..	..	..	..	..	2.5	2.5	1.5	1.5	56	×	..	......	..	19	2
	Rana palustris .... F. 52.22 U. S. N. M.	"	×	..	..	..	..	..	1	0.8	0.5	0.5	44	×	..	......	..	20	2
	Rana areolata circulosa .... F. 72.3 "	"	×	..	..	..	..	..	2	2	1.5	1.4	110	×	..	......	..	21	2
	Rana aurora .... F. 50.10 "	"	×	..	..	..	..	..	1.5	1	0.5	0.5	19	×	..	......	..	22	2
	Rana pretiosa .... F. 75.11 "	"	×	..	..	..	..	..	2	1.5	1	0.8	41	×	..	......	..	23	2
	Rana draytonii .... F. 70.14 "	"	×	..	..	..	..	..	3	3	1.5	1.5	33	×	..	......	..	24	2
	Spelerpes ruber (red salamander) .... A. M. N. H.	"	×	..	..	..	..	..	1	1.5	0.3	0.2	4	×	..	......	..	25	2
	Cryptobranchus allegheniensis (hellbender) "	"	×	..	..	..	..	..	2.5	1.5	0.5	0.5	7	×	..	......	..	26	2
	Necturus maculatus (necturus) .... "	"	×	..	..	..	..	..	2	1.5	0.5	0.5	9	×	..	......	..	27	2
	Scaphiopus holbrookii (spade-foot toad) ... "	"	×	..	..	..	..	..	1.5	1	0.5	0.5	11	×	..	......	..	28	2
	Scaphiopus couchii .... E. 50.20 U. S. N. M.	"	×	..	..	..	..	..	1	1.5	0.5	0.6	24	×	..	......	..	29	2
	Scaphiopus hammondii .... F. 20.6 "	"	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	30	2
	Pipa americana (Surinam toad) .... A. M. N. H.	"	×	..	×	..	..	..	3.5	5.5	0.8	0.8	3	×	..	......	..	31	3
	Bufo agua (Bermuda toad) .... No. 1113 "	"	×	..	×	..	..	..	5	3.5	2.5	2	39	×	..	......	..	32	3
	Bufo halophilus .... E. 35.8 U. S. N. M.	"	×	..	×	..	..	..	2	2	1.5	1.5	129	×	..	......	..	33	3
	Bufo columbiensis .... E. 40.2 "	"	×	..	×	..	..	..	2	2	1.4	1.5	111	×	..	......	..	34	3
	Bufo lentiginosus woodhousii .... E. 45.9 "	"	×	..	×	..	..	..	2.5	2	1.5	1	45	×	..	......	..	35	3
	Bufo americana (American toad) .... A. M. N. H.	"	×	×	×	..	..	..	2.5	2	1	0.6	15	×	..	......	..	36	3
	Bufo lentiginosus cognatus .... E. 13.11 U. S. N. M.	"	×	..	×	..	..	..	2	1.5	1	0.9	42	×	..	......	..	37	3
	Bufo valliceps .... E. 21.5 "	"	×	..	×	..	..	..	2	1.5	0.9	0.8	31	×	..	......	..	38	3
	Rana boylii .... F. 61.20 "	"	×	..	..	..	..	..	1	0.6	0.5	0.4	47	×	..	......	..	39	3
	Average diameters and medullary index	..	..	..	..	..	..	..	1.7	1.6	0.7	0.7	36.6	..	..	......	..	..	..

SYNOPTIC TABLE II

Class		Right or left femur	Types and type combinations: I	II	III, Incomplete differentiation: Ia	Ib	Ic	Complete differentiation: C	Measurements, Bone: Ant.-post. diam. in mm.	Lat. diam. in mm.	Measurements, Medullary canal: Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary indices Per cent	Medullary canal: Full	Empty	Special	Senility	Reference: Figure	Plate
Reptiles.	Sphenodon punctatus (most prim. rept.) ... A. M. N. H.	R	×	..	..	..	..	..	3	2.5	1.5	1	26	×	..	......	..	40	3
	Phrynosoma cornutum .... "	"	×	..	..	..	..	..	2.8	1.5	0.8	0.5	10	×	..	......	..	41	3
	Chamæleo vulgaris .... "	L	×	..	..	..	..	..	1.8	1.5	1	0.8	42	×	..	......	..	42	3
	Phrynosoma douglassii ....L. 50.12 U. S. N. M.	R	×	..	..	..	..	..	2	1	0.5	0.5	12	×	..	......	..	43	3
	Ptychozoon homalocephalum (gecko) No. 684 A. M. N. H.	"	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	44	3
	Iguana tuberculata .... "	"	×	..	..	..	..	..	3.5	3	2	2	61	×	..	......	..	45	3
	Varanus salvator .... "	L	×	..	×	..	..	..	11	10	7	6	51	×	..	......	..	46	3
	Amphibolurus barbatus .... "	R	×	..	..	..	..	..	3	4	1.5	2.5	49	×	..	......	..	47	3
	Varanus arenarius .... "	L	×	..	..	..	..	..	4.5	3	3	2	45	×	..	......	..	48	3
	Varanus nuchalis (monitor) .... "	R	×	..	×	..	..	..	4.5	3.5	3	2.5	88	×	..	......	..	49	3
	Heloderma suspectum (gila monster) No. 583 "	"	×	..	..	..	..	..	3	3	0.7	0.7	5	×	..	......	..	50	4
	Sceloporus clarkii ....I. 61.17 U. S. N. M.	"	×	..	..	..	..	..	1.5	1.5	0.5	0.5	12	×	..	......	..	51	4
	Sceloporus spinosus floridanus.....I. 73.12 "	"	×	..	..	..	..	..	1.5	1.5	0.5	0.5	12	×	..	......	..	52	4
	Sceloporus occidentalis ....I. 74.3 "	"	×	..	..	..	..	..	1.5	1	0.6	0.5	24	×	..	......	..	53	4
	Sceloporus magister ....J. 71.2 "	"	×	..	..	..	..	..	1.5	1	0.5	0.5	19	×	..	......	..	54	4
	Cyclura carinata .... "	"	×	..	..	..	..	..	5	5	3	3	56	×	..	......	..	55	4
	Anolis cristatellus ....L. 15.13 "	"	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	56	4
	Crotaphytus collaris ....J. 21.12 "	"	×	..	..	..	..	..	1.5	1.5	1	1	80	×	..	......	..	57	4
	Crotaphytus collaris ....J. 32.9 "	L	×	..	..	..	..	..	1.5	1.5	0.8	0.8	40	×	..	......	..	58	4
	Ameiva exul ....L. 21.11 "	R	×	..	..	..	..	..	2	2	0.5	0.5	33	×	..	......	..	59	4
	Eumeces fasciatus ....H. 31.4 "	"	×	..	..	..	..	..	1.5	1	0.6	0.5	24	×	..	......	..	60	4
	Sauromalus ....J. 40.6 "	"	×	..	..	..	..	..	3	2.5	1.5	1.2	32	×	..	......	..	61	4
	Gerrhonotus grandis ....I. 22.4 "	"	×	..	..	..	..	..	1.5	1	0.4	0.4	11	×	..	......	..	62	4
	Python regius .... "	"	×	..	..	..	..	..	1	0.6	0.4	0.3	24	×	..	......	..	63	4
	Python regius .... "	L	×	..	..	..	..	..	1	1	0.5	0.4	28	×	..	......	..	64	4
	Alligator mississippiensis ....C. M. C.	"	×	×	×	×	..	..	17	15	7	6	20	×	..	......	..	65	4
	Chelydra serpentina (snapping turtle)........ "	..	×	×	×	×	..	..	8	8.5	1	1	1.5	×	..	cancellous	..	66	4
	Trionyx spinifer (soft-shelled turtle)......A. M. N. H.	R	×	..	×	×	..	..	3.5	5.5	0	0	0	×	..	"	..	67	4
	Cinosternum pennsylvanicum (mud turtle). "	"	×	..	..	×	..	..	3	3.5	0	0	0	×	..	"	..	68	4
	Chelopus guttatus (spotted turtle)........ "	"	×	..	×	×	..	..	2.5	4	0	0	0	×	..	"	..	69	4
	Chrysemys picta (painted turtle).......... "	L	×	..	×	×	..	..	2.5	4	0	0	0	×	..	"	..	70	4
	Aromochelys odoratus (musk turtle)...... "	R	×	..	..	×	..	..	1.8	1.4	0.3	0.3	4	×	..	"	..	71	4
	Pseudemys floridana (turtle)............. "	"	×	×	..	×	..	..	4	3	0	0	0	×	..	"	..	72	4
	Testudo (Gopherus) polyphemus (turtle).. "	"	×	..	×	×	..	..	8.5	6	0	0	0	×	..	"	..	73	4
	Average diameters and medullary index with the turtles	..	..	..	..	..	..	..	3.4	3.2	1.2	1.1	26.1	..	..	......	..	..	..
	Average diameters and medullary index without the turtles	..	..	..	..	..	..	..	3.3	2.9	1.5	1.4	33	..	..	......	..	..	..

SYNOPTIC TABLE III

Class		Right or left femur	Types and type combinations						Measurements					Medullary canal				Reference	
					III				Bone		Medullary canal								
					Incomplete differentiation			Complete differentiation											
			I	II	Ia	Ib	Ic	C	Ant.-post. diam. in mm.	Lat. diam. in mm.	Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary indices Per cent	Full	Empty	Special	Senility	Figure	Plate
Birds.	Cyanocitta stelleri azteca (Aztec jay)......A. M. N. H.	R	×	×	..	..	..	..	3	2.5	2	1.5	68	×	..	......	..	74	5
	Mergus serrator (red-breasted merganser). "	L	×	×	..	..	×	..	6.5	4.5	4.5	2.5	68	×	..	......	..	75	5
	Ajaia ajaja (roseate spoonbill)........... "	R	×	×	..	..	..	..	7	6	5	4.5	114	..	..	......	..	76	5
	Tympanuchus americanus (prairie chicken)..C. M. C.	"	×	..	..	..	..	..	5	6	4	4.5	148	..	×	......	..	77	5
	Numida meleagris (guinea fowl)............ "	"	..	×	..	..	×	..	7	8	5	6	116	×	..	......	..	77½	5
	Cyanocitta cristata (blue jay)............... "	"	..	×	..	..	×	..	2.5	2.5	1.5	1.5	56	×	..	......	..	78	5
	Pteroglossus torquatus (banded toucan)...A. M. N. H.	L	×	..	..	..	..	..	3	3	2	2	80	×	..	......	..	79	5
	Charadrius pluvialis (golden plover)....... "	"	..	×	..	..	..	..	2.5	2.5	1.5	1.5	56	×	..	......	..	80	5
	Amazona oratrix (Mexican parrot)........ "	"	..	×	×	..	×	..	4	3.5	3	3	177	×	..	......	..	81	5
	Turdus migratorius (robin).................C. M. C.	R	×	..	..	..	×	..	2	2	1.5	1.5	129	×	..	......	..	82	5
	Pelecanus erythrorhynchus (white pelican)... "	..	×	..	..	..	×	..	12	10	0	0	0	×	..	cancellous	..	83	5
	Ara macao (macaw)......................... "	R	..	×	..	..	×	..	5.5	4.5	4.5	3.5	178	×	..	......	..	84	5
	Nyctherodius violaceus (night heron)........ "	"	..	×	..	..	×	..	5	6	4	4.5	148	×	..	......	..	85	5
	Pavo cristatus (peafowl).................... "	..	..	×	..	..	×	..	10	11	8	10	277	..	×	......	..	86	5
	Haliäetus leucocephalus (eagle).............. "	..	..	×	..	..	×	..	13	14	11	11.5	227	..	×	......	..	87	5
	Aramus vociferus (courlan)...............A. M. N. H.	L	..	×	..	..	..	..	6.5	6	5.5	5	239	..	×	......	..	88	5
	Centrocercus urophasianus (sage hen)........C. M. C.	"	..	×	..	..	..	..	7	6	6	5	252	..	×	......	..	89	5
	Meleagris gallipavo (wild turkey)............ "	"	..	×	×	..	×	..	15	17.5	10.5	13	109	×	..	......	..	90	6
	Meleagris gallipavo (domestic turkey)........ "	"	..	×	×	..	×	..	9	11	7	8	129	×	..	......	..	91	6
	Dendragapus obscurus (blue grouse)......... "	"	..	×	..	..	..	..	5	5.5	4	5	277	..	×	......	..	92	6
	Rhea americana (rhea)...................A. M. N. H.	"	..	×	..	..	×	..	25.5	20.5	19	15	120	×	..	......	..	93	6
	Struthio (ostrich) .... "	"	..	×	..	..	×	..	54	40	47	32	240	..	×	......	..	94	6
	Haversian system of the ostrich..........................	..	..	..	..	..	..	..	..	..	..	..	..	..	..	......	..	95	6
	Phasianus torquatus (Chinese pheasant).....C. M. C.	L	..	×	..	..	×	..	6	6	4.5	4.5	129	..	×	......	..	95½	6
	Dromæus novæ hollandiæ (emu)..........A. M. N. H.	R	..	×	..	..	×	..	30	26	22	19.5	122	..	..	......	..	96	6
	Anas boscas (mallard duck)..................C. M. C.	..	..	×	..	..	×	..	4.5	6.5	3.5	5	141	..	×	......	..	97	6
	Emberiza citrinella (yellow hammer)......... "	..	×	..	..	..	×	..	2.5	3	0	0	0	..	..	cancellous	..	98	6
	Chauna cristata (crested screamer)........A. M. N. H.	R	..	..	..	..	×	..	12.5	12	10.5	10.5	277	..	×	......	..	99	6
	Pandion carolinensis (American osprey)......C. M. C.	L	..	×	..	..	×	..	7.5	8	6	6.5	188	×	..	......	..	100	6
	Sarcorhamphus gryphus (Andean condor)..A. M. N. H.	R	×	..	..	..	×	..	18.5	17.5	15	14.5	204	..	..	......	..	101	7
	Olor sp.? (swan)........................ "	"	..	×	..	..	×	..	11.5	10.5	7	8	87	..	..	......	..	102	7
	Gavia stellata (red-throated loon).......... "	L	×	..	..	..	×	..	8.5	6.5	5	4	184	..	..	......	..	103	7
	Gallus (domestic chicken)...................C. M. C.	..	×	..	..	..	×	..	9	9	7	7	153	×	..	......	..	104	7
	Corvus americanus (American crow)......... "	..	×	..	..	..	×	..	4	3	2.5	2	70	×	..	......	..	105	7
	Asio wilsonianus (long-eared owl)........... "	..	×	×	..	..	×	..	8	7	6	6	178	×	..	......	..	106	7
	Bernicla canadensis (wild goose)............. "	R	..	×	..	..	×	..	9	8.5	7	7	178	×	..	......	..	107	7
	Leptoptilos sp.? (stork)...................A. M. N. H.	L	×	..	..	..	×	..	17	15	14.5	13.5	327	..	×	......	..	108	7
	Anthracoceros malabaricus (hornbill)..... "	R	×	..	..	..	×	..	6.5	6	5.5	5	240	..	×	......	..	109	7
	Astur atricapillus (goshawk)................C. M. C.	..	×	..	..	..	×	..	4	4.3	3	3.3	139	..	×	......	..	110	7
	Inocotis papillosus (ibis)..................A. M. N. H.	L	×	..	..	..	×	..	7	6.5	6	5.5	264	..		......	..	111	7
	Cathartes aura (turkey-buzzard)............C. M. C.	R	×	..	..	..	×	..	9.5	8	7.5	7	219	..	×	......	..	112	7
	Average diameters and medullary index..............	..	..	..	..	..	..	..	9.6	8.9	7.2	6.8	158.9	..	..	......	..	..	..

SYNOPTIC TABLE IV

Class Mammals			Right or left femur	Types and type combinations I	II	III Incomplete differentiation Ia	Ib	Ic	Complete differentiation C	Measurements: Bone Ant.-post. diam. in mm.	Bone Lat. diam. in mm.	Medullary canal Ant.-post. diam. in mm.	Medullary canal Lat. diam. in mm.	Medullary indices Per cent	Medullary canal Full	Empty	Special	Senility	Reference Figure	Plate
Bats.	Mormoops	No. 102231 U. S. N. M.	R	×	..	..	..	..	..	1	0.8	0.6	0.5	59	×	..	......	..	113	8
	Rhinolophus mehelyi	" 84768 "	"	×	..	..	..	..	..	0.8	0.8	0.5	0.5	64	×	..	......	..	114	8
	Sturnira lilium	" 115053 "	L	×	..	..	..	..	..	1	0.9	0.5	0.4	29	×	..	......	..	115	8
	Lonchorina	" 173849 "	R	×	..	..	..	..	..	0.9	0.8	0.5	0.5	55	×	..	......	..	116	8
	Rousettus amplexicaudatus	" 175844 "	L	×	..	..	..	..	..	2.5	2	1.5	1	44	×	..	......	..	117	8
	Hipposideros larvatus	" 152076 "	R	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	118	8
	Hemiderma	" 123744 "	L	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	119	8
	Desmodus rotundus	" 114977 "	"	×	..	..	..	..	..	1.5	2.5	1	2	129	×	..	......	..	120	8
	Leptonycteris	" 105129 "	"	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	121	8
	Rhinopoma (Palestine)	" 122140 "	R	×	..	..	..	..	..	1	0.9	0.5	0.4	29	×	..	......	..	122	8
	Erophylla bombifrons	" 86262 "	L	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	123	8
	Phyllostoma hastatum	" 102906 "	"	×	..	..	..	..	..	2.5	1.5	1.5	1	64	×	..	......	..	124	8
	Epomophorus wahlbergii	" 113451 "	"	×	..	..	..	..	..	2	1	1	0.5	33	×	..	......	..	125	8
	Glossophaga elongata	" 102107 "	"	×	..	..	..	..	..	0.9	0.8	0.4	0.4	28	×	..	......	..	126	8
	Nyctalus aviator	" 102098 "	"	×	..	..	..	..	..	1.5	1.5	0.5	0.5	12	×	..	......	..	127	8
	Scotophilus heathii	" 13692 "	"	×	..	..	..	..	..	2	1.5	1.2	1	65	×	..	......	..	128	8
	Miniopterus schreibersii	" 152610 "	R	×	..	..	..	..	..	0.8	0.7	0.3	0.4	64	×	..	......	..	129	8
	Promops fosteri	" 105676 "	L	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	130	8
	Vespertilio murinus	" 5333 "	"	×	..	..	..	..	..	1.5	1.5	0.5	0.5	12	×	..	......	..	131	8
	Molossus nigricans	" 8268 "	R	×	..	..	..	..	..	1.5	1	0.7	0.8	56	×	..	......	..	132	8
	Dasypterus intermedius	" 22408 "	"	×	..	..	..	..	..	1	0.9	0.5	0.4	29	×	..	......	..	133	8
	Molossus major	" 101893 "	L	×	..	..	..	..	..	0.6	0.6	0.4	0.4	80	×	..	......	..	134	8
	Antrozous pallidus	" 63386 "	"	×	..	..	..	..	..	1	1	0.8	0.8	178	×	..	......	..	135	8
	Eumops californicus	" 61387 "	"	×	..	..	..	..	..	1.5	1.5	0.9	0.9	56	×	..	......	..	136	8
	Plecotus auritus	" 152597 "	R	×	..	..	..	..	..	0.8	0.7	0.5	0.4	56	×	..	......	..	137	8
	Nycticeius humeralis	" 115141 "	L	×	..	..	..	..	..	0.8	0.7	0.6	0.5	116	×	..	......	..	138	8
	Myotis myotis	" 86500 "	R	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	139	8
	Eptesicus bahamensis	" 121929 "	L	×	..	..	..	..	..	0.8	0.7	0.5	0.4	56	×	..	......	..	140	8

SYNOPTIC TABLE IV—(Continued)

Class Mammals			Right or left femur	Types and type combinations: I	II	III: Incomplete differentiation: Ia	Ib	Ic	Complete differentiation: C	Measurements: Bone: Ant.-post. diam. in mm.	Bone: Lat. diam. in mm.	Medullary canal: Ant.-post. diam. in mm.	Medullary canal: Lat. diam. in mm.	Medullary indices Per cent	Medullary canal: Full	Empty	Special	Senility	Reference: Figure	Plate
Bats.	Nycteris borealis	No. 101945 U. S. N. M.	L	×	..	..	..	..	..	0.8	0.8	0.4	0.4	33	×	..	......	..	141	8
	Glischropus tylopus	" 142385 "	R	×	..	..	..	..	..	0.5	0.4	0.3	0.2	45	×	..	......	..	142	8
	Nycteris cinerea	" ...... "	"	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	143	8
	Phyllonycteris	" 103501 "	L	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	144	8
	Megaderma spasma	" 114272 "	R	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	145	8
	Pteronotus	" 113570 "	"	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	146	8
	Balantiopteryx plicata	" 142606 "	L	×	..	..	..	..	..	0.5	0.5	0.3	0.3	56	×	..	......	..	147	8
	Saccopteryx	" 123800 "	R	×	..	..	..	..	..	1	0.8	0.4	0.3	18	×	..	......	..	148	8
	Petalia	" 154866 "	L	×	..	..	..	..	..	1	0.9	0.5	0.5	38	×	..	......	..	149	8
	Monophyllus	" 113677 "	"	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	150	8
	Vampyrops lineatus	" ...... "	"	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	151	8
	Chilonycteris	" 173842 "	R	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	152	8
	Cynopterus	" 141241 "	"	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	153	8
	Artibeus palmarum	" 102866 "	L	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	154	8
	Brachyphylla	" 102351 "	"	×	..	..	..	..	..	1.5	1	1	0.5	56	×	..	......	..	155	8
	Macroglossus minimus	" 171695 "	R	×	..	..	..	..	..	1	0.8	0.5	0.4	33	×	..	......	..	156	8
	Taphozous philippinensis	" 144851 "	L	×	..	..	..	..	..	1	1	0.5	0.5	33	×	..	......	..	157	8
	Cheiromeles torquatus	" 102462 "	R	×	..	..	..	..	..	3.5	2	1.5	1	27	×	..	......	..	158	8
	Noctilio	" 49540 "	"	×	..	×	..	..	..	2	1.5	1.5	0.9	82	×	..	......	..	159	8
	Pteropus molossinus (small)	" 151561 "	L	×	..	..	..	..	..	2.5	2.5	1.5	1.5	56	×	..	......	..	160	8
	Pteropus molossinus (large)	" ...... "	R	×	..	×	..	..	..	3	3.5	2.5	2.5	147	×	..	......	..	161	8
	Pteropus aldabrensis	" 20989 "	"	×	..	×	..	..	..	2	2.5	1	1.5	43	×	..	......	..	162	8
	Pteropus (Celebes)	" 172460 "	"	×	..	×	..	..	..	4	3.5	2.5	2	55	×	..	......	..	163	8
	Pteropus (Java)	" 12616 "	"	×	..	×	..	..	..	3	3.5	2.5	2	91	×	..	......	..	164	8
	Pteropus lepidus	" 112404 "	"	×	..	×	..	..	..	2.5	2	1.5	1	45	×	..	......	..	165	8
	Pteropus (Tongatabu)	" 173884 "	"	×	..	×	..	..	..	3	3	1.5	1.5	33	×	..	......	..	166	8
	Pteropus poliocephalus	" 35102 "	"	×	..	×	..	..	..	3.5	3.5	2	2	49	×	..	......	..	167	9
	Average diameters and medullary index		..	..	..	..	..	..	..	1.4	1.3	0.8	0.7	48.6	..	..	......	..	..	..

SYNOPTIC TABLE V

Class		Right or left femur	Types and type combinations: I	II	III: Incomplete differentiation Ia	Ib	Ic	Complete differentiation C	Measurements: Bone: Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary canal: Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary indices Per cent	Medullary canal: Full	Empty	Special	Senility	Reference: Figure	Plate
Mammals.	Tupaia (tree-shrew) ....A. M. N. H.	L	×	..	..	..	..	..	3	2.5	2	1.5	67	×	..	......	..	168	9
	Echidna (egg-laying mammal)...No. 17355 "	R	×	..	..	..	..	..	6	11.5	3.5	6.5	49	×	..	cancellous	..	169	9
	Ornithorhynchus (egg-laying mammal)...U. S. N. M.	L	×	..	..	×	..	..	4	5	2.5	3.5	79	×	..	"	..	170	9
	Cavia cutleri (guinea pig)................A. M. N. H.	"	×	..	×	..	..	..	6	4	4	3	100	×	..	......	..	171	9
	Scalopus aquaticus (mole).............. "	"	×	..	..	×	..	..	1.5	1.5	1	1	80	×	..	......	..	172	9
	Sorex (shrew) .... "	R	×	..	..	×	..	..	3	3.3	1.2	1.5	22	×	..	......	..	173	9
	Macropus (wallaby) .... "	"	×	..	×	..	..	..	14	14	10	10.5	115	×	..	......	..	174	9
	Solenodon paradoxus (young)............ "	L	×	..	×	×	..	..	5	4.5	4	3.5	165	×	..	cancellous	..	175	9
	Solenodon paradoxus (adult)............ "	R	×	..	×	×	..	..	6.5	5	4.5	3.5	94	×	..	"	..	176	9
	Lemur mongoz ....U. S. N. M.	..	×	..	..	×	..	..	9	7	7	4.5	100	×	..	......	..	177	9
	Colobus abyssinicus caudatus.............A. M. N. H.	L	×	..	×	×	..	×	12.5	13	7	7	43	×	..	......	..	178	9
	Putorius vulgaris (weasel)...................C. M. C.	..	×	..	..	..	..	..	1.5	2	1	1.5	62	×	..	......	..	179	9
	Mus rattus (black rat)...................... "	..	×	..	..	×	..	..	2.5	3.5	1.5	2.5	75	×	..	......	..	180	9
	Heteromys (spiny pocket rat).............A. M. N. H.	L	×	..	×	×	..	..	4.5	2.5	3.5	2	153	×	..	......	..	181	9
	Myogale moschata (desman)................C. M. C.	R	×	×	..	×	..	..	5	6.5	2.5	3	30	..	..	......	..	182	9
	Cynomys ludovicianus (prairie dog)......... "	..	×	..	..	×	..	..	4.5	5	2.5	3	50	..	×	......	..	183	9
	Trichosurus vulpecula (phalanger).......A. M. N. H.	L	×	..	×	×	..	..	7	7.5	4	5	61	×	..	......	..	184	9
	Phascolomys ursinus (wombat)........... "	"	×	..	×	×	..	..	11.5	13	4	6	11	×	..	cancellous	..	185	9
	Lasiopyga kolbi (African monkey)........ "	R	×	..	×	×	..	..	8.5	10	6	7	98	×	..	......	..	186	9
	Tragulus javanicus (mouse-deer).......... "	"	..	×	×	..	..	×	7.5	7	6.5	6	289	×	..	......	..	187	10
	Mus sylvaticus (wood mouse)................C. M. C.	"	×	..	..	×	..	..	2	3	1	2	50	×	..	......	..	188	10
	Erinaceus europæus (hedgehog)...........A. M. N. H.	L	×	..	..	×	..	..	3	6	2	2.5	38	×	..	......	..	189	10
	Viverra (civet) .... "	R	×	..	×	×	..	..	8	7	5	4	55	×	..	......	..	190	10
	Ratufa maxima (giant squirrel).......... "	"	×	..	×	×	..	..	5.5	6.5	3.5	4.5	80	×	..	......	..	191	10
	Galeopithecus (flying lemur)............. "	..	×	..	×	×	..	..	6.5	5.5	4	3.5	64	×	..	cancellous	..	192	10
	Manis (scaly ant-eater).................. "	L	×	..	×	×	..	..	7.5	11	5	7	74	×	..	......	..	193	10
	Procavia capensis (coney)................ "	R	×	..	×	..	..	×	7.5	5	3	2.5	25	×	..	......	..	194	10
	Helictis orientalis (Asiatic badger)....... "	L	×	..	..	..	..	×	5.5	4.5	3.2	2.5	129	×	..	......	..	195	10
	Cynocephalus (baboon) .... "	R	×	..	×	×	..	..	16	16	10	10	64	×	..	cancellous	..	196	10
	Cynocephalus maimon (mandrill)........ "	"	×	..	×	×	..	..	13	11.5	8	8	75	×	..	"	..	197	10
	Hydrochœrus capybara (capybara)........ "	"	×	..	×	×	..	..	22	20	13	11	48	×	..	......	..	198	10
	Fetal sheep (half time).......................C. M. C.	"	..	×	..	×	..	..	3.5	4	1	1	8	×	..	......	..	199	11
	Fetal calf (half time)........................ "	"	..	×	..	×	..	..	12	11	5	4	18	×	..	......	..	200	11
	Fetal pig (half time) .... "	"	..	×	..	..	..	..	3.5	3	1.5	1	17	×	..	......	..	201	11
	Cariacus macrotis (deer)..................... "	..	..	×	..	..	..	×	25	24	17	16.5	88	×	..	......	..	202	11
	Sus (domestic pig, adult)................... "	..	..	×	..	..	..	×	21.5	18.5	16.5	12.5	108	×	..	cancellous	..	203	11
	Sus scrofa (wild boar)...................... "	R	..	×	..	..	..	×	23	20	15	13	74	×	..	"	..	204	11
	Alces machlis (elk)......................... "	..	..	×	..	..	..	×	35	33	23	20	66	×	..	"	..	205	11
	Camelus (camel) ....A. M. N. H.	R	..	×	..	×	..	..	51	50	35	35	93	×	..	"	..	206	11
	Auchenia glama (llama).................. "	"	..	×	..	×	..	..	25	25	17	15	69	×	..	"	..	207	11
	Rangifer (reindeer) ....U. S. N. M.	"	..	×	×	×	..	..	26	23	16	14	60	×	..	"	..	208	11
	Ursus americanus (black bear)...............C. M. C.	L	..	×	..	..	..	..	31	29	22	21	105	×	..	"	..	209	12
	Taurotragus oryx (eland).................A. M. N. H.	R	..	×	..	..	..	..	55	44	35	30	73	×	..	"	..	210	12
	Connochætes taurinus albojubatus (gnu).. "	L	..	×	..	..	..	..	33.5	30	20	17.5	53	×	..	"	..	211	12
	Ovibos moschatus wardi (musk ox)....... "	R	..	×	..	×	..	..	36	34	30	28	219	×	..	"	..	212	12
	Mexican burro ....C. M. C.	"	..	×	..	..	..	..	30	23	15	11	31	×	..	"	..	213	12

SYNOPTIC TABLE VI

Class		Right or left femur	Types and type combinations: I	II	III: Incomplete differentiation: Ia	Ib	Ic	Complete differentiation: C	Measurements: Bone: Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary canal: Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary indices Per cent	Medullary canal: Full	Empty	Special	Senility	Reference: Figure	Plate
Mammals.	Tapirus (tapir) ....A. M. N. H.	R	..	×	..	..	..	×	32	35	21	25	98	×	..	cancellous	..	214	12
	Equus hemionus (wild ass of Asia)........U. S. N. M.	L	..	×	..	..	..	×	46	31	26	19	55	×	..	"	..	215	12
	Elephas africanus ....A. M. N. H.	R	..	..	..	..	..	×	108	83	65	49	55	×	..	"	..	216	12
	Cholœpus didactylus (two-toed sloth)...... "	..	..	..	..	..	..	×	16	11	4	4	9	×	..	"	×	217	12
	Potos caudivolvulus (kinkajou).......... "	R	..	..	..	..	..	×	7	8	4.5	5.5	80	×	..	"	..	218	12
	Lutra canadensis (otter)................. "	"	..	..	..	..	..	×	14.5	11	7	5	28	×	..	"	..	219	12
	Simia satyrus (orang-utan)..............U. S. N. M.	"	×	..	×	..	..	×	20	30	11	16	41	×	..	"	..	220	13
	Felis tigris (tiger)....................... "	L	×	..	×	..	..	×	28	22	15	12	41	×	..	......	..	221	13
	Hemigalus hardwicki (civet cat)..........A. M. N. H.	R	×	..	×	..	..	×	7	5.5	4.5	3	54	×	..	......	..	222	13
	Tatu novemcinctus (armadillo)........... "	"	×	..	..	×	..	..	7.5	16	5	6	33	×	..	cancellous	..	223	13
	Tamandua tetradactyla (ant-eater)........ "	"	×	..	×	×	..	..	7	12	3	4	17	×	..	"	..	224	13
	Gorilla (gorilla) .... "	L	×	..	×	..	..	×	16.5	19.5	7.5	9	15	×	..	......	..	225	13
	Presbytis rubicunda ....U. S. N. M.	..	×	..	×	..	..	×	11	11	6	6.5	48	×	..	......	..	226	13
	Hylobates (gibbon) .... "	R	×	..	×	..	..	×	11	11.5	6	6.5	44	×	..	......	..	227	13
	Anthropopithecus troglodytes (chimpanzee) ....A. M. N. H.	L	×	..	×	..	..	×	13	16	6	8	30	×	..	......	..	228	13
	Macacus rhesus (Indian monkey)..............R. I.	R	×	..	..	×	..	×	8	8.5	5	5.5	68	×	..	......	..	229	14
	Sciurus Sp. (large red squirrel).............C. M. C.	"	×	..	..	×	..	×	4.5	6	3.5	5	18	×	..	......	..	230	14
	Felis (domestic cat)......................... "	"	×	×	..	..	..	×	7.5	9.5	4	5.5	45	×	..	......	..	231	14
	Felis catus (wild cat)....................... "	L	×	..	..	×	..	×	13.5	11	8	5.5	42	×	..	......	..	232	14
	Mephitis mephitica (skunk)................. "	..	×	..	..	..	..	×	5	5	3.5	4	127	×	..	......	..	233	14
	Putorius vison (mink)...................... "	..	×	..	..	..	..	×	3.5	4.5	1.5	2	23	×	..	......	..	234	14
	Cryptoprocta ferox (cat-like civet)........A. M. N. H.	L	×	..	×	..	..	×	8.5	8	4.5	4.5	42	×	..	......	..	235	14
	Hyæna crocuta (hyæna).................. "	R	×	..	×	..	..	×	14	18	9	13.5	98	×	..	......	..	236	14
	Thylacinus cynocephalus (Tasmanian wolf) "	"	×	..	×	..	..	×	19.5	15	8	8.5	28	×	..	cancellous	..	237	14
	Dasyprocta agouti (agouti)................ "	"	×	..	×	..	..	×	10	8	6.5	5	93	×	..	......	..	238	14
	Lasiopyga centralis johnstoni (monkey)... "	L	×	..	×	..	..	×	9	8	5.5	5	62	×	..	......	..	239	14
	Felis canadensis (Canada lynx)..............C. M. C.	R	×	..	×	..	..	×	13	12	9.5	9	121	×	..	......	..	240	15
	Lasiopyga Sp. (African monkey).........U. S. N. M.	"	×	..	×	..	..	×	5.5	5	3	2.5	38	×	..	......	..	241	15
	Midas rufoniger (South American monkey) "	..	×	..	×	..	..	×	4.5	4	3	2.5	74	×	..	......	..	242	15
	Lemur variegatus .... "	L	×	..	×	..	..	×	10	8.5	5.5	4.5	41	×	..	......	..	243	15
	Lemur catta (ring-tailed lemur).......... "	R	×	..	×	×	..	×	8.5	7	7	4.5	122	×	..	cancellous	..	244	15
	Ateles (Tehuantepec) (spider-monkey)... "	L	×	..	×	..	..	×	12.5	10.5	7	5.5	42	×	..	......	..	245	15
	Callicebus torquatus (squirrel-monkey)... "	R	×	..	×	..	..	×	5.5	5	4	3.5	104	×	..	......	..	246	15
	Genetta (genet) .... "	L	×	..	×	..	..	×	9	7	6.5	5	107	×	..	......	..	247	15
	Pedetes (jumping hare).................. "	"	×	..	×	..	..	×	10.9	9	7.5	6	85	×	..	......	..	248	15
	Bradypus tridactylus (three-toed sloth)...A. M. N. H.	R	×	..	×	..	..	×	8.5	13	3	4	12	×	..	cancellous	×	249	15
	Castor canadensis (beaver)..............U. S. N. M.	"	×	×	×	×	..	×	25	11	6	4	10	×	..	"	..	250	16
	Felis pardus (leopard). .... "	L	×	..	..	..	..	×	18	17	10	9	37	×	..	"	×	251	16
	Bos (domestic ox)...........................C. M. C.	"	..	×	..	..	..	×	44	39	23	21	40	×	..	"	..	252	16
	Equus caballus (domestic horse)............ "	"	..	×	..	..	..	×	57.5	41.5	32	22.5	43	×	..	"	..	253	16
	Ovis (domestic sheep)...................A. M. N. H.	R	..	×	..	..	..	×	18	14	10.7	7	44	×	..	"	..	254	16
	Bison americanus .... "	"	..	×	..	..	..	×	56	46	39	33	100	×	..	"	..	255	16
	Mule ....C. M. C.	"	..	×	..	..	..	×	60	55	47	45	179	×	..	"	×	256	16
	Mule .... "	L	..	×	..	..	..	×	68	50	40	37	77	×	..	"	×	257	16
	Mule .... "	"	..	×	..	..	..	×	65	51	38	40	85	×	..	"	×	258	16
	Mule .... "	"	..	×	..	..	..	×	61	50	40	38	100	×	..	"	..	259	16

SYNOPTIC TABLE VII

Class		Right or left femur	Types and type combinations						Measurements					Medullary canal			Senility	Reference	
					III				Bone		Medullary canal								
					Incomplete differentiation			Complete differentiation	Ant.-post. diam. in mm.	Lat. diam. in mm.	Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary indices Per cent	Full	Empty	Special		Figure	Plate
			I	II	Ia	Ib	Ic	C											
Mammals.	Elephas indicus (Asiatic elephant) .... A. M. N. H.	L	..	×	..	..	..	×	121	77	50	38	25	×	..	cancellous	×	260	17
	Hippopotamus amphibius (hippopotamus). "	R	..	×	×	..	..	×	70	70	26	30	19	×	..	"	..	261	17
	Giraffa camelopardalis (giraffe) .... "	L	..	×	..	..	..	×	72	59	35	30	33	×	..	"	..	262	17
	Rhinoceros bicornis (rhinoceros) .... "	"	..	×	..	..	..	×	47.5	130	14	23	55	×	..	"	×	263	17
	Equus burchelli (zebra) .... "	R	..	×	..	..	..	×	43	37	20	22	38	×	..	"	..	264	17
	Ursus maritimus (polar bear) .... "	L	..	×	..	..	..	×	31	38	18	22	51	×	..	"	..	265	17
	Bubalis jacksoni (hartebeest) .... "	R	..	×	..	..	..	×	32.5	30	17	16	39	×	..	"	..	266	17
	Phacochœrus africanus (warthog) .... "	L	..	×	..	×	..	×	24	20.5	14	12	52	×	..	"	..	267	17
	Felis concolor (panther) .... "	"	×	×	..	..	..	×	16	19	11	12	76	×	..	"	..	268	18
	Gulo luscus (wolverene) .... "	"	×	×	..	..	..	×	10	11.5	5.5	6	31	×	..	"	..	269	18
	Erignathus barbatus (seal) .... "	"	..	×	..	..	..	×	19.5	39	10	25	50	×	..	"	..	270	18
	Bos bubalis (water buffalo) .... "	"	..	×	..	×	..	×	48	45	24	25	38	×	..	"	..	271	18
	Ovis montana (mountain sheep) .... C. M. C.	"	..	×	..	..	..	×	20	25	12.5	15	60	×	..	"	..	272	18
	Cephalophus (African antelope) .... U. S. N. M.	..	..	×	..	..	..	×	15	13.5	9	9	67	×	..	"	..	273	18
	Raphiceros (steinbok) .... "	..	..	×	×	..	..	×	12	12.5	6.5	7	43	×	..	"	..	274	18
	Gazella granti (Grant's gazelle) .... A. M. N. H.	L	..	×	..	..	..	×	19	19.5	10.5	11	45	×	..	"	..	275	18
	Kobus ellipsiprymnus (water buck) ...... "	"	×	×	×	..	..	×	28	25	18	16	70	×	..	"	..	276	18
	Arctomys monax (woodchuck) .... C. M. C.	..	..	×	×	..	..	×	6	7	4	4.5	74	×	..	"	..	277	19
	Canis latrans (coyote) .... "	R	..	×	..	..	..	×	12	11.5	8	7	68	×	..	"	..	278	19
	Capra (goat) .... "	"	..	×	..	×	..	×	4.5	5	2.5	3	50	×	..	"	..	279½	19
	Bull dog (not a pure blood) .... "	"	×	×	..	..	..	×	14.5	12.5	10.5	9	109	×	..	"	..	279½	19
	Shepherd dog (not a pure blood) .... "	L	..	×	..	..	..	×	11	10.5	6.5	5.5	45	×	..	"	..	280	19
	Dog (mongrel) .... "	R	×	×	×	..	..	×	16	17	11	10	68	×	..	"	..	280½	19
	Fox terrier (not a pure blood) .... "	..	..	×	..	..	..	×	11	9.5	6.5	6	59	×	..	"	..	281	19
	Dog (mongrel) .... "	R	..	×	..	..	..	×	12.5	13	8.5	9	90	×	..	"	..	282	19
	Bull dog (not a pure blood) .... "	"	..	×	..	..	..	×	13	12	7	6.5	41	×	..	"	..	283	19
	Collie dog (not a pure blood) .... "	"	×	×	..	..	..	×	13.5	13	8	7.5	50	×	..	"	..	284	19
	Spaniel (not a pure blood) .... "	"	..	×	..	..	..	×	13	13.5	8.5	8.5	70	×	..	"	..	285	19
	Dog (mongrel) .... "	"	×	..	..	×	..	×	12.5	10.5	8	7	74	×	..	..	..	..	..
	Lepus cuniculus (rabbit) .... "	L	×	×	..	..	..	×	5.5	7.5	3.5	5	74	×	..	......	..	286	19
	Procyon lotor (raccoon) .... "	R	×	×	×	..	..	×	9	10	6.5	7	100	×	..	cancellous	..	287	20
	Os penis of raccoon .... "	..	×	..	..	..	..	×	4	4	0.8	0.8	4	×	..	......	..	288	20
	Canis lupus (wolf) .... "	..	..	×	×	..	..	×	16.5	7	10	5	77	×	..	cancellous	..	289	20
	Felis leo (lion) .... A. M. N. H.	R	×	×	×	..	..	×	26	25.5	13	11.5	28	×	..	"	..	290	20
	Canis (small grey fox) .... C. M. C.	..	×	×	×	..	..	×	8	9	5	6.5	80	×	..	......	..	291	20
	Taxidea americana (American badger) .... A. M. N. H.	L	×	×	..	..	..	×	7	8	4	4	40	×	..	......	..	292	20
	Melursus labiatus (sloth bear) .... "	R	×	×	×	..	..	×	24	24	10	10	21	×	..	cancellous	..	293	20
	Canis aureus (jackal) .... U. S. N. M.	L	×	×	×	..	..	×	10	8.5	6.5	6	85	×	..	......	..	294	20
	Didelphis virginiana (opossum) .... C. M. C.	R	×	..	..	×	..	..	7	8.5	3.5	5	42	×	..	......	..	295	20
	Manis (ant-eater) .... U. S. N. M.	L	..	×	×	×	..	..	9	12.5	4	5.5	24	×	..	cancellous	..	296	20
	Haplodontia olympica (sewellel, mount. beaver) C. M. C.	R	×	×	×	×	..	..	5.5	4	3	1.5	26	×	..	......	..	297	20
	Erethizon (porcupine) .... "	L	×	..	×	×	..	×	9.5	7.5	3	2.5	12	×	..	cancellous	..	298	20
	Average diameters and medullary index of mammals.	..	..	..	..	..	..	..	19	18.6	10.9	10.4	63.3	..	..	......	..	..	..

SYNOPTIC TABLE VIII

Class Mammal Man		Right or left femur	Types and type combinations I	II	III Incomplete differentiation Ia	Ib	Ic	Complete differentiation C	Measurements: Bone Ant.-post. diam. in mm.	Bone Lat. diam. in mm.	Medullary canal Ant.-post. diam. in mm.	Medullary canal Lat. diam. in mm.	Medullary indices Per cent	Medullary canal Full	Empty	Special	Senility	Reference Figure	Plate
Fetal.	White fetus, 2-2½ months.....C. M. C.	R	×	..	..	..	..	..	1.8	1.5	0.5	0.4	8	×	..	cancellous	..	299	21
	" " 3-3½ " ..... "	"	..	×	×	..	..	..	2.5	2	0.5	0.5	5	×	..	"	..	300	21
	" " 4-4½ " ..... "	"	..	×	..	×	..	..	3.5	2.5	0.6	0.5	3	×	..	"	..	301	21
	" " 5-7 " .....U. S. N. M.	"	..	×	..	×	..	..	3.5	3	0.5	0.5	2	×	..	"	..	302	21
	" " 8-9 " ..... "	"	..	×	..	×	..	..	4.5	5	1	1	4	×	..	"	..	303	21
	Negro " 8-9 " ..... "	"	..	×	..	×	..	..	4.5	5.5	1.5	2.5	15	×	..	"	..	304	21
	White " 8½ " (craniorrhachischisis) C. M. C.	"	..	×	..	×	..	..	6	6	3	2.5	26	×	..	"	..	305	21
Adult black race.	Negro .....No. 228481 U. S. N. M.	L	..	..	..	..	..	×	29	30	16	15	38	×	..	"	..	306	21
	" (mixed black and white).. " 247368 "	..	..	..	..	..	..	×	22	27	12	11	30	×	..	"	×	307	21
	" ..... " 3 M. D. T. U.	L	..	..	..	..	..	×	30	24	15	14	41	×	..	"	×	308	21
	" ..... " 87 "	"	..	..	..	..	..	×	27.5	30	17	17	54	×	..	"	×	309	22
	" ..... " 7 "	R	..	..	..	..	..	×	27	30	19	18	74	×	..	"	×	310	22
	" ..... " 4 "	L	..	..	..	..	..	×	30	23	21	13	65	×	..	"	..	311	22
	" ..... " 84 "	"	..	..	..	..	..	×	24	25	15	13	48	×	..	"	..	312	22
	" ..... " 10 "	"	×	..	..	..	..	×	26	29	14	15	38	×	..	"	..	313	22
	Negress ..... " 123 "	R	..	..	..	..	..	×	28	27	14	11	25	×	..	"	×	314	22
	Negro ..... " 79 "	L	..	..	..	..	..	×	30.5	26.5	17	15	46	×	..	"	×	315	22
	" ..... " 224714 U. S. N. M.	"	×	..	..	..	..	×	34	36	21	21	56	×	..	"	×	316	22
	" ..... " 11 M. D. T. U.	"	×	..	×	..	..	×	32	26.5	13	12	22	×	..	"	..	317	22
	" ..... " 2 "	R	×	×	..	..	..	×	30	29	16	14	36	×	..	"	..	318	23
	" ..... " 56 "	L	×	..	..	..	..	×	27.5	27	16	14	43	×	..	"	×	319	23
	Negress ..... " 220 C. M. C.	"	×	..	×	..	..	×	30	25	18	14	50	×	..	"	×	320	23
	" (amputated lower ⅓)..... " 220 "	R	×	..	×	..	..	×	30	25	24	15	92	×	..	"	××	321	23
	" (age 14, mixed black and white) ..... " 226 "	L	×	..	..	..	..	×	24	18	12	9	34	×	..	"	..	322	23
	Negro ..... " 1 M. D. T. U.	..	×	×	×	..	..	×	23	25	11	10	24	×	..	"	..	323	23
	Negro (kaffir) ..... U. S. N. M.	R	×	..	..	..	..	×	27	23	14	11.5	32	×	..	"	..	324	23
	" ..... " 248674 "	"	×	×	×	..	..	×	30	26	15	12.5	32	×	..	"	..	325	23
	" ..... " " "	L	×	×	×	..	..	×	29	27	17	14	42	×	..	"	..	326	24
	Tibia of negro..... " " "	..	×	×	×	..	..	×						×	..	......	..	327	24
	Fibula " " ..... " " "	..	×	×	×	..	..	×						×	..	......	..	328	24
	Ulna " " ..... " " "	..	×	×	×	..	..	×						×	..	......	..	329	24
	Radius " " ..... " " "	..	×	..	×	..	..	×	....	....	Control	....	....	×	..	......	..	330	24
	Humerus " " ..... " " "	..	×	..	×	..	..	×						×	..	......	..	331	24
	Clavicle " " ..... " " "	..	×	×	..	..	..	×						×	..	......	..	332	24
	Metatarsal bone of great toe..... " " "	..	×	..	×	..	..	×						×	..	......	..	333	24
	Negro ..... " 224713 "	L	×	×	×	..	..	×	35	24	20	12	40	×	..	cancellous	..	334	24
	" ..... " 83 M. D. T. U.	R	×	×	×	..	..	×	30	25	12	10	19	×	..	"	..	335	25
	" ..... " 6 "	"	×	×	×	..	..	×	33.5	27	13	10	17	×	..	"	..	336	25
	" ..... " 63 "	"	×	×	×	..	..	×	32	28	20	14	45	×	..	"	..	337	25
	" ..... " 5 "	L	×	×	×	..	..	×	25	24	16	15	67	×	..	"	..	338	25
	" ..... " 8 "	R	×	..	×	..	..	×	27	25	12.5	9	20	×	..	"	..	339	25
	Average diameters and medullary index.....	..	..	..	..	..	..	..	22.7	20.9	12.7	10.6	41.9	..	..	......	..	..	..

SYNOPTIC TABLE IX

Class Mammal Man		Right or left femur	Types and type combinations						Measurements					Medullary canal				Reference	
					III				Bone		Medullary canal								
					Incomplete differentiation			Complete differentiation											
			I	II	Ia	Ib	Ic	C	Ant.-post. diam. in mm.	Lat. diam. in mm.	Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary indices Per cent	Full	Empty	Special	Senility	Figure	Plate
Black.	Negro ....No. 7 M. D. T. U.	L	..	..	..	..	..	×	30	26	17	15	50	×	..	cancellous	×	340	25
Yellow-brown races.	Pueblo Indian, child, 1 year old .... " 258675(z) U. S. N. M.	R	..	×	..	×	..	..	8	7.5	4.5	4	43	×	..	......	..	341	25
	Pueblo Indian, child, 6 years old .... " 258675(L) "	R	×	×	×	..	..	×	12	10.5	8	6	61	×	..	......	..	342	25
	Pueblo Indian, youth....... " 258675(S2) "	L	×	×	×	..	..	×	17	16	9	9	42	×	..	......	..	342½	25
	Pueblo Indian, adult....... " 258675(x) "	..	×	×	×	..	..	×	20	20	8	9	22	×	..	......	..	343	26
	Pueblo Indian, " ...... " 227339 "	R	..	..	..	..	..	×	25	23	14	11	37	×	..	......	..	344	26
	Peruvian Indian .... " 266469(b) "	L	×	×	..	..	..	×	27	31	21	19	91	×	..	......	×	345	26
	Peruvian Indian .... " 266469(a) "	"	..	..	..	..	..	×	22	27	13	12	36	×	..	......	..	346	26
	Chicama Indian (Peru).... " 2 "	"	×	..	×	..	..	×	31	30	13	13	22	×	..	......	×	347	26
	" " " .... " 3 "	R	×	..	..	..	..	×	27	25	16	11	35	×	..	......	..	348	26
	" " " .... " 1 "	"	..	..	..	..	..	×	26.5	31	11	16	27	×	..	......	..	349	26
	" " " .... " 4 "	L	×	..	..	..	..	×	30	28	18	16	52	×	..	......	×	350	26
	" " " .... " 7 "	"	×	×	..	..	..	×	18.5	19	10.5	9	37	×	..	......	..	351	27
	* " " " .... " 9 "	"	×	×	×	..	..	×	22	23.5	11	11	30	×	..	......	..	..	..
	*Pachacamac Indian (Peru) " 14 "	R	×	×	×	..	..	×	24	21	14	10	38	×	..	......	..	..	..
	* " " " " 13 "	"	..	×	×	..	..	×	16	15	8	7	30	×	..	......	..	..	..
	* " " " " 8 "	L	..	×	..	..	..	×	22.5	18	9	7	19	×	..	......	..	..	..
	* " " " " 11 "	R	..	×	×	×	..	..	10	9	7	6.5	100	×	..	......	..	..	..
	" " " " 12 "	L	..	×	..	×	..	..	10	12.5	7	7.5	72	×	..	......	..	357	27
	* " " " " 10 "	R	×	..	×	..	..	×	21.5	20	10.5	8.5	23	×	..	......	..	..	..
	* " " " " 5 "	L	×	..	×	..	..	×	20	21	11	9	31	×	..	......	..	..	..
	" " " " 15 "	R	×	..	×	..	..	×	24	20	12	9	27	×	..	......	..	360	27
	" " " " 6 "	L	×	..	..	..	..	×	20.5	18.5	9	7	20	×	..	......	..	361	27
	Japanese, male .... " 245 C. M. C.	R	×	..	×	..	..	×	30	30	20	18	65	×	..	......	×	362	27
	Average diameters and medullary index..............	..	..	..	..	..	..	..	21.1	20.7	11.5	10.5	43.8	..	..	......	..	..	..
Ancient Egyptian, Twelfth Dynasty.	Egyptian child, about 1 year old ....No. 256479(de) U. S. N. M.	..	..	..	×	×	..	..	9	11.5	7	8	111	×	..	......	..	363	27
	Diagram of the vascular origin of Haversian system..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	......	..	363a	27
	Egyptian child ....No. 256479(d) U. S. N. M.	..	×	×	×	×	..	..	9.5	10	4	5	27	×	..	......	..	364	27
	" adolescent .... " 256479(a3) "	R	×	..	×	..	..	×	12	12.5	5.5	7	35	×	..	......	..	365	27
	" " .... " 258675(a) "	..	×	..	×	..	..	×	18	16.5	10	9	44	×	..	......	..	366	27
	" adult .... " 256481(d) "	R	×	×	×	..	..	×	18.5	17.5	9	8	28	×	..	......	..	367	28
	" " .... " 256481(a) "	L	×	..	..	×	..	×	18	16	8	7	24	×	..	......	×	368	28
	" " .... " 258675(e) "	R	×	..	..	..	..	×	26	21.5	14	10	44	×	..	......	..	369	28
	" " .... " 256478(23) "	..	..	..	..	..	..	×	24	30	10	10	16	×	..	......	..	370	28
	" " .... " 256478(x) "	R	×	..	..	..	..	×	23	27	12	11	27	×	..	......	..	371	28
	Average diameters and medullary index..............	..	..	..	..	..	..	..	17.6	18.1	8.8	8.3	39.5	..	..	......	..	..	..

* The femora marked with (*) have been described but not drawn.

SYNOPTIC TABLE X

Class Mammal Man			Right or left femur	Types and type combinations						Measurements					Medullary canal				Reference	
						III				Bone		Medullary canal								
						Incomplete differentiation			Complete differentiation											
				I	II	Ia	Ib	Ic	C	Ant.-post. diam. in mm.	Lat. diam. in mm.	Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary indices Per cent	Full	Empty	Special	Senility	Figure	Plate
White race.	Male, white	No. 1629 U. S. N. M.	..	..	..	..	..	..	×	28	28	18	17	64	×	..	cancellous	..	372	28
	Female, "	" 147 M. D. N. U.	R	..	..	..	..	..	×	33.5	32	19	18.5	49	×	..	"	×	373	28
	Child, " (less than 1 yr. old).	" 249588 U. S. N. M.	"	..	×	×	×	..	..	6.5	7.5	4	5	70	×	..	"	..	374	29
	Male, "	" 53 C. M. C.	..	..	..	..	..	..	×	28	30	16	17	48	×	..	"	..	375	29
	" "	" 171 M. D. N. U.	R	..	..	..	..	..	×	30	33	17	15	35	×	..	"	×	376	29
	" "	" 95 C. M. C.	L	..	..	..	..	..	×	30	27.5	17	16	42	×	..	"	×	377	29
	" "	" 96 "	"	..	..	..	..	..	×	29.5	30	14.5	12	24	×	..	"	×	378	29
	" "	" 168 M. D. N. U.	"	..	..	..	..	..	×	30	30	15	17	40	×	..	"	×	379	29
	" " (age 50)	" 10 "	"	..	..	..	..	..	×	30	31.5	13	12	20	×	..	"	×	380	29
	Female, " (" 52)	" 227876 U. S. N. M.	..	..	..	..	..	..	×	22	25	13.5	12	42	×	..	"	×	381	29
	" " (" 62)	" 227880 "	..	..	..	..	..	..	×	24	25	16	16	74	×	..	"	××	382	29
	Male, "	" 162 "	L	..	..	..	..	..	×	25	29	13	15	35	×	..	"	×	384	30
	" "	" 244 "	R	..	..	..	..	..	×	35	30	17	15	32	×	..	"	×	385	30
	" East Indian	" 223 C. M. C.	"	..	..	×	..	..	×	29	24	16	12	38	×	..	"	×	386	30
	" " " (same as above) amputated	"	L	..	..	×	..	..	×	28	22	17	12	49	×	..	"	×	387	30
	" white	" 228479 U. S. N. M.	R	..	..	..	..	..	×	32	28	14	17	36	×	..	"	×	388	30
	" " (age 45)	" 154 M. D. N. U.	"	..	..	..	..	..	×	30	29	15	14	26	×	..	"	×	389	30
	" "	" 146 "	L	..	..	..	..	..	×	28	24	13	10	24	×	..	"	×	390	30
	" "	" 159 "	"	..	..	..	..	..	×	32	31.5	17.5	18	45	×	..	"	×	391	30
	" "	" 167 "	R	..	..	..	..	..	×	27	25	14	11	30	×	..	"	×	392	30
	" "	" 172 "	"	..	..	..	..	..	×	32	31.5	17.5	18	45	×	..	"	×	393	30
	" "	" 242 C. M. C.	"	..	..	..	..	..	×	32	27	19	15	49	×	..	"	×	394	31
	" " (age 60)	" 145 M. D. N. U.	"	..	..	..	..	..	×	30	29	16	18	49	×	..	"	×	395	31
	Female, white	" 174 "	L	×	..	..	..	..	×	27	26	14	13	35	×	..	"	×	396	31
	Male, "	" 157 "	R	×	×	..	..	..	×	30	29	16.5	16	44	×	..	"	×	397	31
	" "	" 161 "	L	..	..	..	..	..	×	28	31	12	15	26	×	..	"	×	398	31
	" "	" 153 "	R	×	..	×	..	..	×	27.5	26	14	11	27	×	..	"	×	399	31
	" "	" 243 C. M. C.	"	×	..	×	..	..	×	30	27	16	14	23	×	..	"	×	400	31
	" "	" 148 M. D. N. U.	L	×	..	..	..	..	×	24	33	13.5	14	30	×	..	"	×	401	31
	" "	" 230 C. M. C.	"	×	..	..	..	..	×	31	29	17	14	33	×	..	"	×	402	31
	" "	" 97 "	"	×	×	×	..	..	×	28.5	27	16	15	45	×	..	"	..	403	32
	" "	" 99 "	L	×	×	×	..	..	×	30	27.5	14	10	20	×	..	"	..	404	32
	" "	" 160 M. D. N. U.	R	×	..	..	..	..	×	28	28.5	15	15	38	×	..	"	×	405	32
	" "	" 163 "	L	×	..	×	..	..	×	28	25	15	11.5	32	×	..	"	×	406	32
	" "	" 156 "	R	×	..	..	..	..	×	31	23.5	11	11	20	×	..	"	×	407	32
	" "	" 169 "	L	×	..	..	..	..	×	31	29	16	15	37	×	..	"	×	408	32
	" " (age 35)	" 151 "	R	×	×	×	..	..	×	28	31	11.5	12	19	×	..	"	×	409	32
	" "	" 100 C. M. C.	L	×	×	..	..	..	×	24	31	17.5	13.5	46	×	..	"	×	410	32
	Female, "	" 150 M. D. N. U.	R	×	..	..	..	..	×	26	26	20	21	16	×	..	"	××	411	32

SYNOPTIC TABLE XI

Class Mammal Man		Right or left femur	Types and type combinations						Measurements					Medullary canal			Senility	Reference	
					III				Bone		Medullary canal								
					Incomplete differentiation			Complete differentiation											
			I	II	Ia	Ib	Ic	C	Ant.-post. diam. in mm.	Lat. diam. in mm.	Ant.-post. diam. in mm.	Lat. diam. in mm.	Medullary indices Per cent	Full	Empty	Special		Figure	Plate
White race.	Male, white (double femur).....No. 152 M. D. N. U.	L	×	..	..	×	..	×	26	37	14	16	30	×	..	cancellous	×	412	33
	" " (33 mm. below above	..	..	..	..	..	..	..	27	25	16	17	67	..	..	"	..	..	..
	sect.) .... " " "	"	×	..	..	×	..	×	23	18	10	10	31	×	..	"	×	413	33
	Female, white .... " 164 "	"	×	..	..	..	..	×	28	27.5	20	20	55	×	..	"	××	414	33
	" " .... " 166 "	"	×	..	..	..	..	×	26.5	26	14	13	34	×	..	"	×	415	33
	Male, white (age 22, suicide).... " 175 C. M. C.	"	×	×	×	×	..	×	27	29	14	19	53	×	..	"	..	416	33
	" " .... " 98 "	L	×	×	..	..	..	×	30	30	17	15	39	×	..	"	×	417	33
	" " .... " 91 "	"	×	×	..	..	..	×	30	27	17	13	39	×	..	"	..	418	33
	" Australian .... " 227420 U. S. N. M.	..	×	..	..	..	..	×	28	23	12	11	25	×	..	"	..	419	34
	" white .... " 94 C. M. C.	L	×	..	..	..	..	×	30	29	17	14	38	×	..	"	..	420	34
	" " (age 40)........... " 142 M. D. N. U.	R	×	..	×	..	..	×	30	27.5	13	11.5	22	×	..	"	×	421	34
	Single Haversian system showing lamellæ............	..	..	..	..	..	..	..	..	..	..	..	..	..	..	......	..	423	34
	" " " " early stage of senility	..	..	..	..	..	..	..	..	..	..	..	..	..	..	......	..	424	34
	" " " " later " " "	..	..	..	..	..	..	..	..	..	..	..	..	..	..	......	..	425	34
	" " " " latest " " "	..	..	..	..	..	..	..	..	..	..	..	..	..	..	......	..	426	34
	Male, white (convict)...........No. 2 M. D. N. U.	R	..	..	..	..	..	×	32	27.5	15	10	21	×	..	cancellous	×	428	35
	" " " .... " 3 "	"	..	..	..	..	..	×	26.5	25	15	12	39	×	..	"	×	429	35
	* " " (age 50) .... " 268 C. M. C.	L	..	..	..	..	..	×	30	30	13	12	21	×	..	"	×	..	..
	* " " (amputated) .... " 269 "	R	×	×	×	..	..	×	29	33.5	17	20	54	×	..	"	×	..	..
	* " " .... " 270 "	"	..	..	..	..	..	×	31	25	14	13	29	×	..	"	×	..	..
	* " " .... " 271 "	"	..	..	..	..	..	×	31	32	17	15	35	×	..	"	×	..	..
	* " " .... " 272 "	"	..	..	..	..	..	×	33	28	27	25	26	×	..	"	..	..	..
	* " " .... " 273 "	"	..	..	..	..	..	×	28	29	15	12	29	×	..	"	×	..	..
	" " .... " 274 "	"	..	..	..	..	..	×	30	35	15	16	30	×	..	"	×	436	35
	" " .... " 275 "	"	×	..	×	..	..	×	30	27	19	14	50	×	..	"	×	437	35
	* " " .... " 276 "	L	..	..	..	..	..	×	28	33.5	26	17.5	100	×	..	"	×	..	..
	" " .... " 277 "	R	×	..	..	..	..	×	32	28	17	11	28	×	..	"	×	439	35
	* " " .... " 278 "	"	..	..	..	..	..	×	29	34	17	15	35	×	..	"	..	..	..
	* " " .... " 279 "	"	..	..	..	..	..	×	30	27	16	14	38	×	..	"	×	..	..
	* " " .... " 280 "	"	..	..	..	..	..	×	30	24.5	15	11	29	×	..	"	..	..	..
	* " " .... " 281 "	L	..	..	..	..	..	×	31	27	13	10	19	×	..	"	×	..	..
	* " " .... " 282 "	R	..	..	..	..	..	×	30	31.5	16	13.5	30	×	..	"	×	..	..
	" " .... " 284 "	"	×	×	×	..	..	×	26.5	26	13	12.5	31	×	..	"	×	445	35
	* " " .... " 285 "	"	..	..	..	..	..	×	29	28	15	14	35	×	..	"	×	..	..
	* " " .... " 286 "	"	..	..	..	..	..	×	32	27.5	17	14	36	×	..	"	×	..	..
	* " " .... " 287 "	"	×	..	×	..	..	×	25	25	12	9	21	×	..	"	×	..	..
	* " " .... " 288 "	"	..	..	..	..	..	×	30	31	17	15	38	×	..	"	×	..	..
	" " .... " 289 "	"	×	..	×	..	..	×	30	33	14	15	27	×	..	"	×	451	35
	" " .... " 296 "	L	×	..	×	..	..	×	27.5	23	12	10	23	×	..	"	×	452	35
	Average diameters and medullary index of white race.	..	..	..	..	..	..	..	28.7	28.1	15.5	14.1	35.8	..	..	......	..	..	..
	Male, white, idiopathic epileptic..............N. S. H.	L	..	..	..	..	..	×	27	22	24	18	277	×	..	......	..	453	35

* Described, not drawn.

INDEX

Femora marked with (*) described, but not drawn.

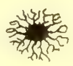

Fig. A
Round lacuna with short, bushy canaliculi. Early stage

Fig. B
Oval lacuna with short, bushy canaliculi. Later stage

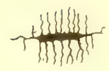

Fig. C
Long, narrow lacuna with long, straight canaliculi. Latest stage

THREE STAGES IN THE DIFFERENTIATION OF LACUNÆ

Fig. D
Basic or undifferentiated bone. Amblystoma tigrinum

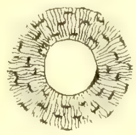

Fig. E
Differentiated bone. Frog. Concentric lacunæ

Fig. F
Differentiated bone. Haversian system of man. Concentric lamellæ

FIRST DIFFERENTIATION

Fig. H
Early stage in the differentiation of laminæ. Aztec jay

Fig. I
Later stage in the differentiation of laminæ. Chinese pheasant

Fig. J
Latest stage in the differentiation of laminæ. Pig

SECOND DIFFERENTIATION

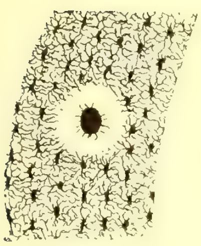

Fig. K
Stage Ia. Amphibian

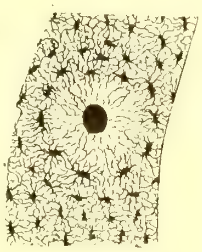

Fig. L
Stage Ib. Reptile

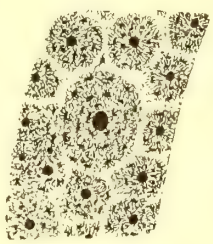

Fig. M
Stage Ic. Bird

Incomplete differentiation of Haversian systems

Fig. N
Stage C. Mammal. Man. Complete differentiation of Haversian systems

THIRD DIFFERENTIATION

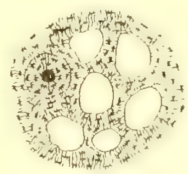

Fig. O
Haversian system formed in the mesh of cancellous bone

Fig. P
Haversian systems formed in the canals of a second type bone

ABERRANT FORMS

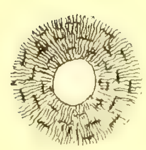

Fig. 1
First type. Frog

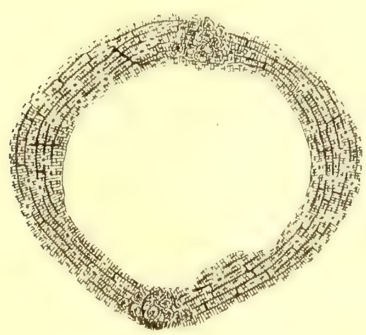

Fig. 2
Second type. Turkey

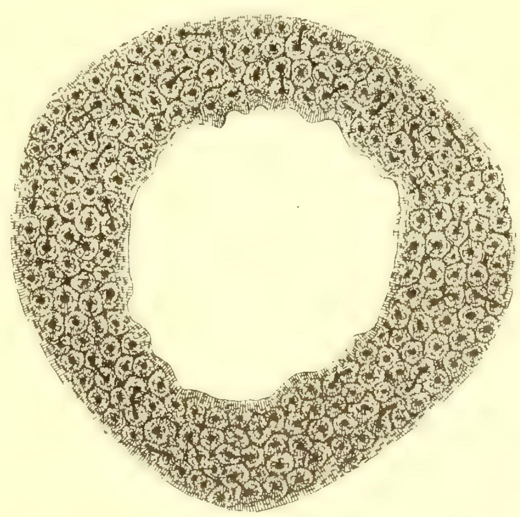

Fig. 3
Third type. Man

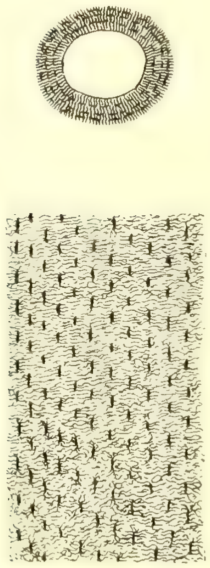

Fig. 1
Cross and longitudinal sections of a femur of the first type

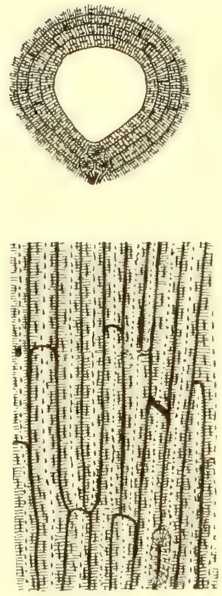

Fig. 2
Cross and longitudinal sections of a femur of the second type

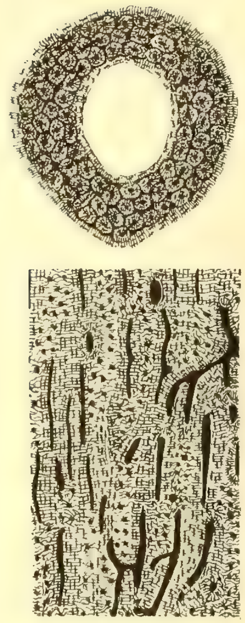

Fig. 3
Cross and longitudinal sections of a femur of the third type

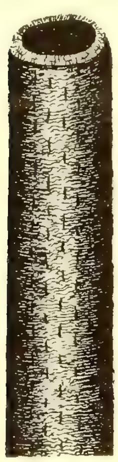

Fig. 4
Diagram illustrating a first type femur

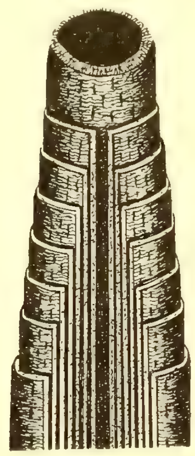

Fig. 5
Diagram illustrating a second type femur

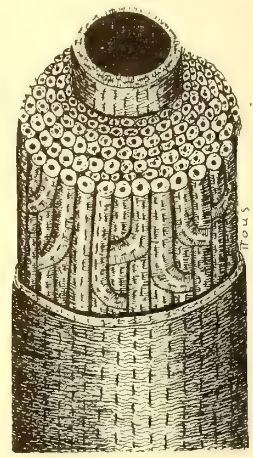

Fig. 6
Diagram illustrating a third type femur

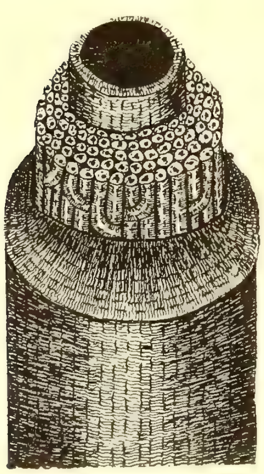

Fig. 7
Diagram illustrating a femur of the first and third type combination

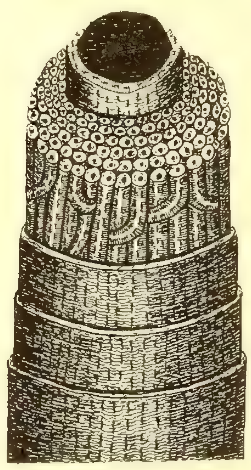

Fig. 8
Diagram illustrating a femur of the second and third type combination

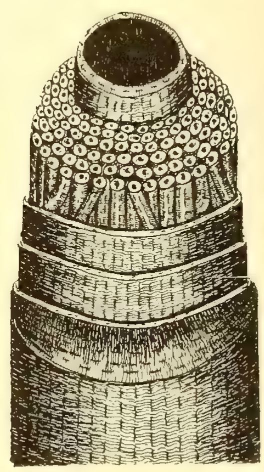

Fig. 9
Diagram illustrating a femur of the first, second and third type combination

CROSS AND LONGITUDINAL SECTIONS OF TYPES OF FEMORA, AND DIAGRAMS ILLUSTRATING THE CONSTRUCTION OF FEMORA

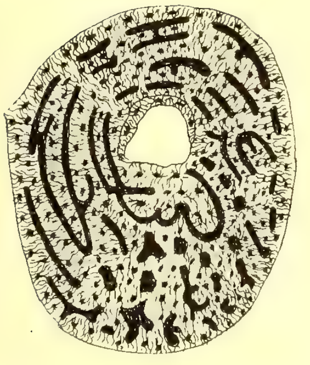

FIG. 1
I-II. Human fetus

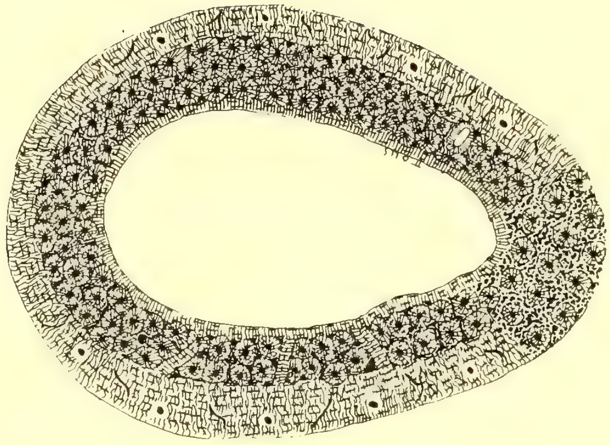

FIG. 2
I-III. Hyæna crocuta

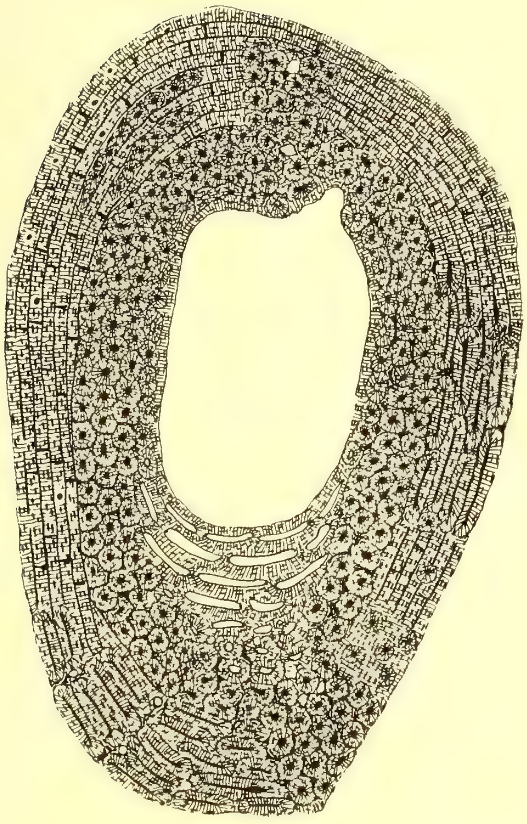

FIG. 3
II-III. Elephas indicus

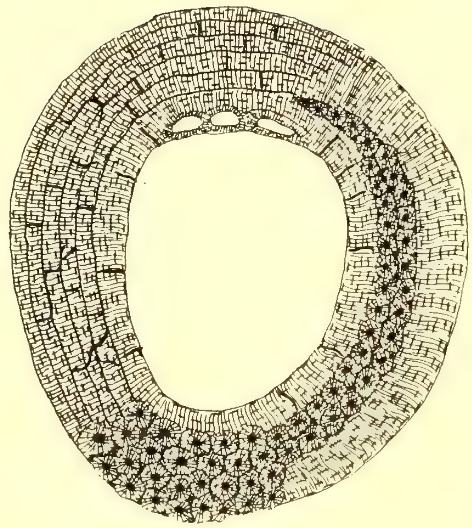

FIG. 4
I-II-III. Bulldog

COMBINATIONS OF TYPES

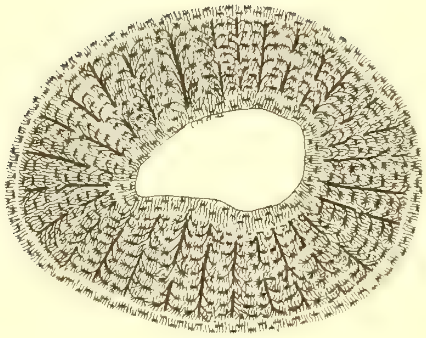

FIG. 1
Right femur of a large bull frog (Rana catesbiana), showing radiating bush-like canals

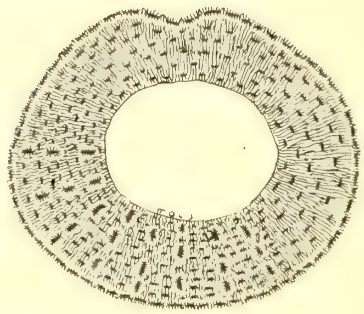

FIG. 2
Right femur of a medium-sized bull frog (Rana catesbiana), the radiating canals disappearing

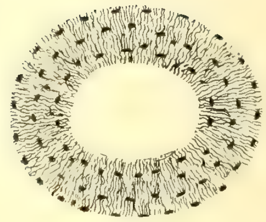

FIG. 3
Right femur of a small bull frog (Rana catesbiana), in which radiating canals are displaced by lamellæ

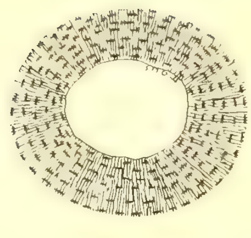

FIG. 4
Right femur of a bull frog showing the first type of structure

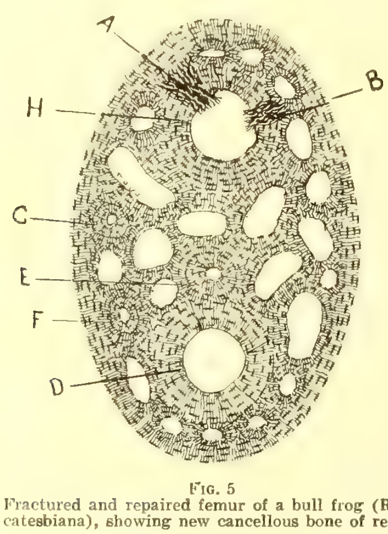

FIG. 5
Fractured and repaired femur of a bull frog (Rana catesbiana), showing new cancellous bone of repair

AMPHIBIANS

Fig. 6
Right femur of
Amblystoma tigrinum
(most primitive amphibian)

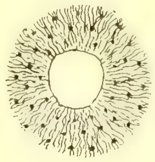

Fig. 7
Right femur of
Hyla versicolor
(tree frog)

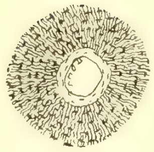

Fig. 8
Right femur of Hyla
arenicolor

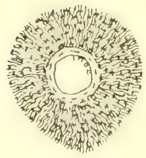

Fig. 9
Right femur of Hyla
femoralis

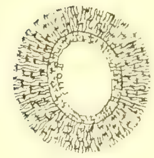

Fig. 10
Right femur of Hyla
evittata

Fig. 11
Right femur of Hyla
cinerea

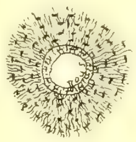

Fig. 12
Right femur of Hyla
regilla

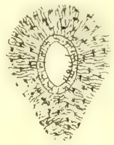

Fig. 13
Right femur of Hyla
squirella

Fig. 14
Right femur of Hyla
gratiosa

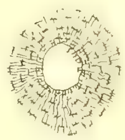

Fig. 15
Right femur of
Dendrobates tinctorius

Fig. 16
Right femur of
Leptodactylus albilabris

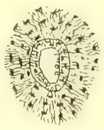

Fig. 17
Right femur of Chorophilus
feriarum

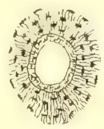

Fig. 18
Right femur of Acris
gryllus

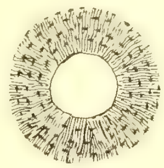

Fig. 19
Right femur of Rana
catesbiana

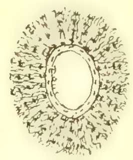

Fig. 20
Right femur of Rana
palustris

Fig. 21
Right femur of Rana
areolata circulosa

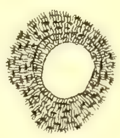

Fig. 22
Right femur of Rana
aurora

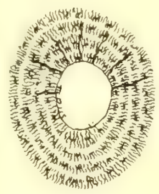

Fig. 23
Right femur of Rana
pretiosa

Fig. 24
Right femur of Rana
draytonii

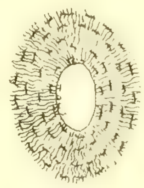

Fig. 25
Right femur of
Spelerpes ruber

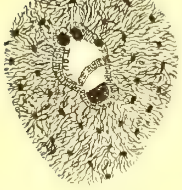

Fig. 26
Right femur of Crypto-
branchus allegheniensis

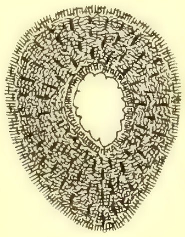

Fig. 27
Right femur of Necturus
maculatus

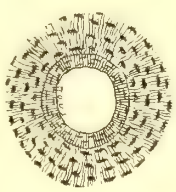

Fig. 28
Right femur of Scaphiopus
holbrookii

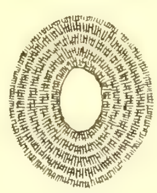

Fig. 29
Right femur of Scaphiopus
couchii

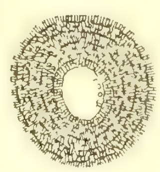

Fig. 30
Right femur of Scaphiopus
hammondii

AMPHIBIANS

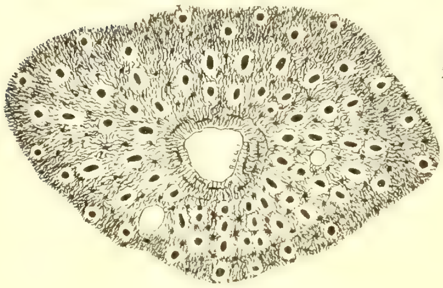

Fig. 31
Right femur of Pipa americana
(Surinam toad)

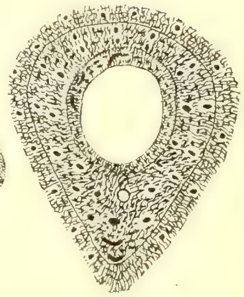

Fig. 32
Right femur of Bufo
agua (Bermuda toad)

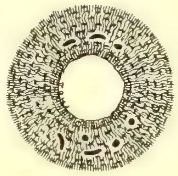

Fig. 33
Right femur of Bufo
halophilus

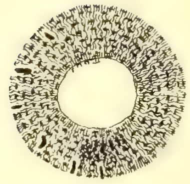

Fig. 34
Right femur of Bufo
columbiensis

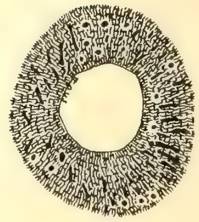

Fig. 35
Right femur of Bufo
lentiginosus woodhousii

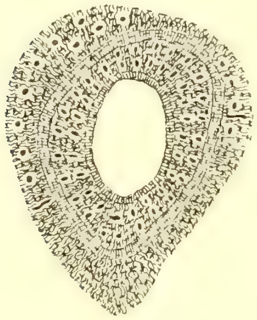

Fig. 36
Right femur of Bufo americana

Fig. 37
Right femur of Bufo
lentiginosus cognatus

Fig. 38
Right femur of Bufo
valliceps

Fig. 39
Right femur of Rana
boylii

REPTILES

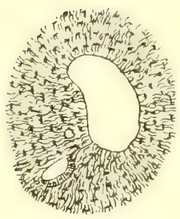

Fig. 40
Right femur of Sphenodon
punctatus (most primitive
reptile)

Fig. 41
Right femur of Phrynosoma
cornutum

Fig. 42
Left femur of Chamæleo
vulgaris

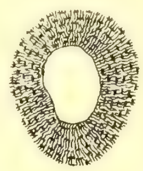

Fig. 43
Right femur of Phrynosoma
douglassii

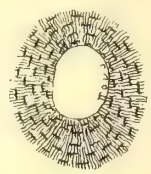

Fig. 44
Right femur of Ptychozoon
homalocephalum

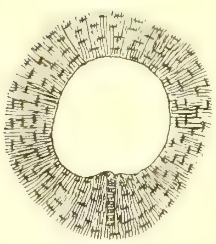

Fig. 45
Right femur of Iguana
tuberculata

Fig. 46
Left femur of Varanus
salvator

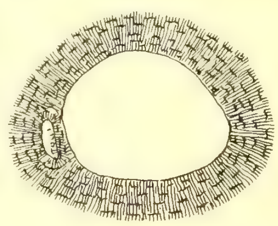

Fig. 47
Right femur of
Amphibolurus barbatus

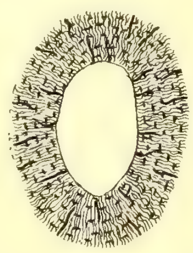

Fig. 48
Left femur of Varanus
arenarius

Fig. 49
Right femur of Varanus
nuchalis

AMPHIBIANS AND REPTILES

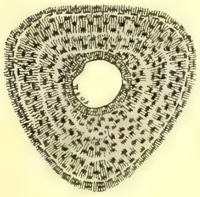
Fig. 50
Right femur of Heloderma suspectum

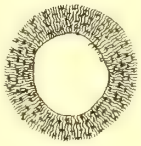
Fig. 51
Right femur of Sceloporus clarkii

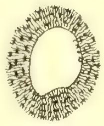
Fig. 52
Right femur of Sceloporus spinosus floridanus


Fig. 53
Right femur of Sceloporus occidentalis.


Fig. 54
Right femur of Sceloporus magister


Fig. 55
Right femur of Cyclura carinata


Fig. 56
Right femur of Anolis cristatellus


Fig. 57
Right femur of Crotaphytus collaris

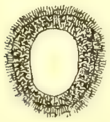
Fig. 58
Left femur of Crotaphytus collaris

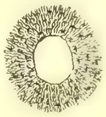
Fig. 59
Right femur of Ameiva exul


Fig. 60
Right femur of Eumeces fasciatus


Fig. 61
Right femur of Sauromalus

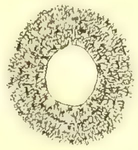
Fig. 62
Right femur of Gerrhonotus grandis


Fig. 63
Right femur of Python regius


Fig. 64
Left femur of Python regius

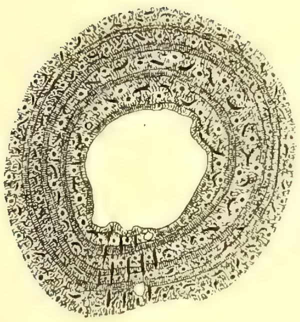
Fig. 65
Left femur of Alligator mississippiensis

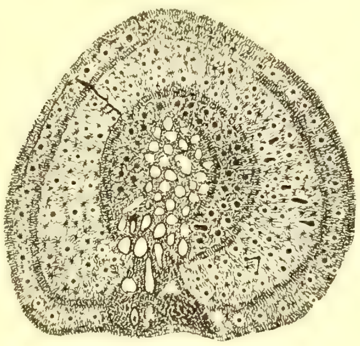
Fig. 66
Femur of Chelydra serpentina (snapping turtle)

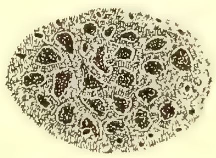
Fig. 67
Right femur of Trionyx spinifer (soft-shelled turtle)

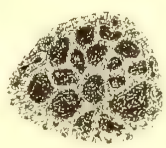
Fig. 68
Right femur of Cinosternum pennsylvanicum

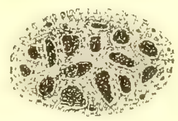
Fig. 69
Right femur of Chelopus guttatus (spotted turtle)

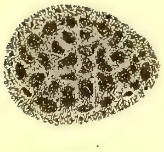
Fig. 70
Left femur of Chrysemys picta (painted turtle)


Fig. 71
Right femur of Aromochelys odoratus (musk turtle)

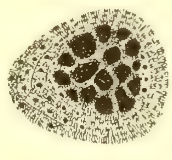
Fig. 72
Right femur of Pseudemys floridana

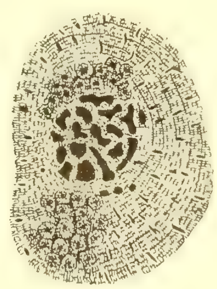
Fig. 73
Right femur of Testudo (Gopherus) polyphemus

REPTILES

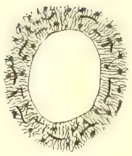

FIG. 74
Right femur of Cyanocitta stelleri azteca (Aztec jay)

FIG. 75
Left femur of Mergus serrator (red-breasted merganser)

FIG. 76
Right femur of Ajaia ajaja (roseate spoonbill)

FIG. 77
Right femur of Tympanuchus americanus (prairie chicken)

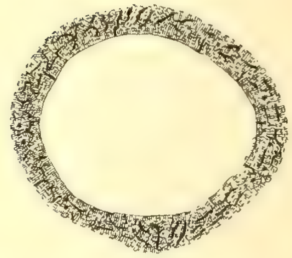

FIG. 77½
Right femur of Numida meleagris (guinea-fowl)

FIG. 78
Right femur of Cyanocitta cristata (blue jay)

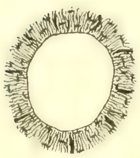

FIG. 79
Left femur of Pteroglossus torquatus (banded toucan)

FIG. 80
Left femur of Charadrius pluvialis (golden plover)

FIG. 81
Left femur of Amazona oratrix (Mexican parrot)

FIG. 82
Right femur of Turdus migratorius (robin)

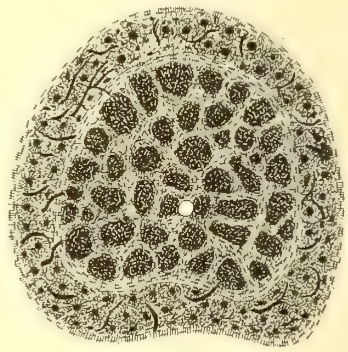

FIG. 83
Femur of Pelecanus erythrorhynchus (white pelican)

FIG. 84
Right femur of Ara macao (macaw)

FIG. 85
Right femur of Nyctherodius violaceus (night heron)

FIG. 86
Femur of Pavo cristatus (peafowl)

FIG. 87
Femur of Haliætus leucocephalus (eagle)

FIG. 88
Left femur of Aramus vociferus (courlan)

FIG. 89
Left femur of Centrocercus urophasianus (sage grouse)

BIRDS

FIG. 90
Left femur of Meleagris gallipavo
(wild turkey)

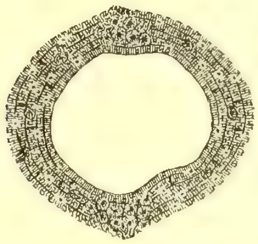

FIG. 91
Left femur of Meleagris gallipavo
(domestic turkey, 16 lbs. weight)

FIG. 91½
Left femur of Meleagris gallipavo
(domestic turkey, 32 lbs. weight)

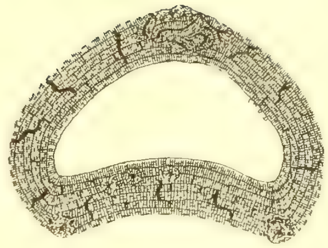

FIG. 92
Left femur of Dendragapus obscurus
(blue grouse)

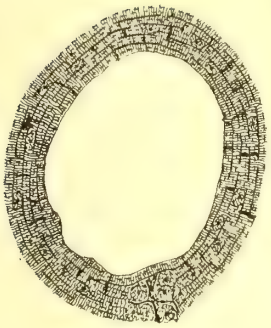

FIG. 93
Left femur of Rhea americana
(rhea)

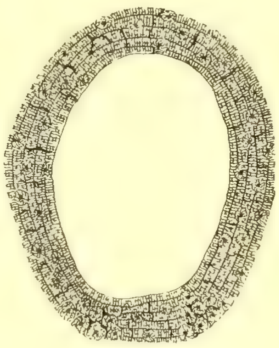

FIG. 94
Left femur of Struthio
(ostrich)

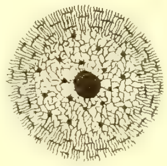

FIG. 95
Haversian system of
Fig. 94, showing early
central and late peripheral stages of
development

FIG. 95½
Left femur of Phasianus torquatus (Chinese pheasant)

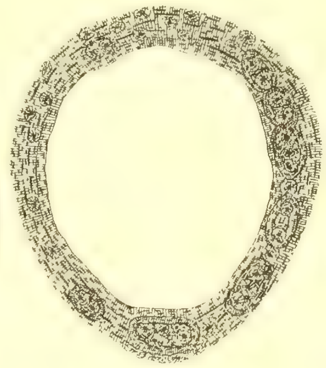

FIG. 96
Right femur of Dromæus novæ
hollandiæ (emu)

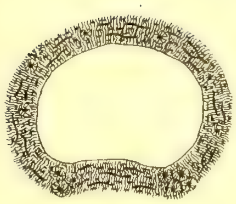

FIG. 97
Femur of Anas boscas (mallard duck)

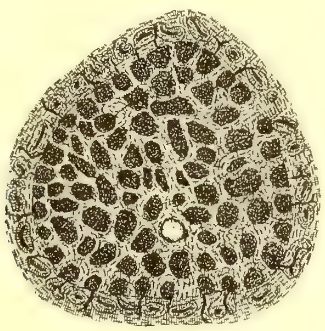

FIG. 98
Femur of Emberiza citrinella
(yellow hammer)

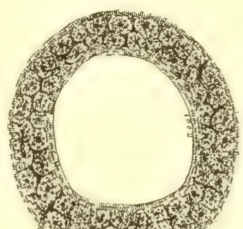

FIG. 99
Right femur of Chauna cristata
(crested screamer)

FIG. 100
Left femur of Pandion carolinensis
(American osprey)

BIRDS

FIG. 101
Right femur of Sarcorhamphus gryphus (Andean condor)

FIG. 102
Right femur of Olor sp. (swan)

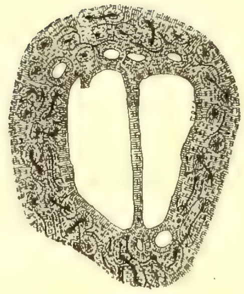

FIG. 103
Left femur of Gavia stellata (red-throated loon)

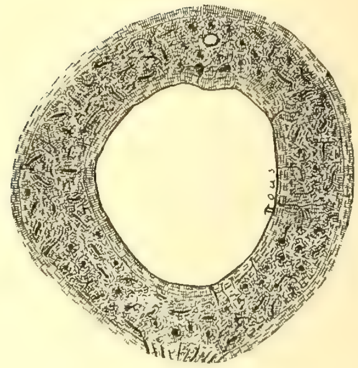

FIG. 104
Femur of Gallus (domestic chicken)

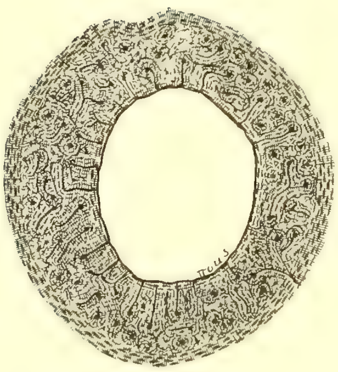

FIG. 105
Femur of Corvus americanus (American crow)

FIG. 106
Femur of Asio wilsonianus (long-eared owl)

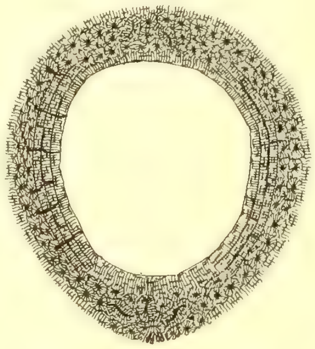

FIG. 107
Right femur of Bernicla canadensis (wild goose)

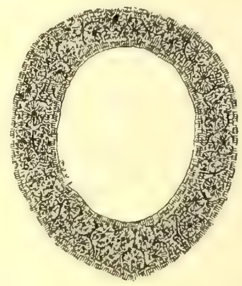

FIG. 108
Left femur of Leptoptilos sp. (stork)

FIG. 109
Right femur of Anthracoceros malabaricus (hornbill)

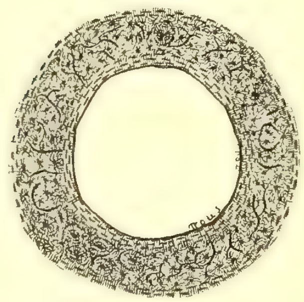

FIG. 110
Femur of Astur atricapillus (goshawk)

FIG. 111
Left femur of Inocotis papillosus (ibis)

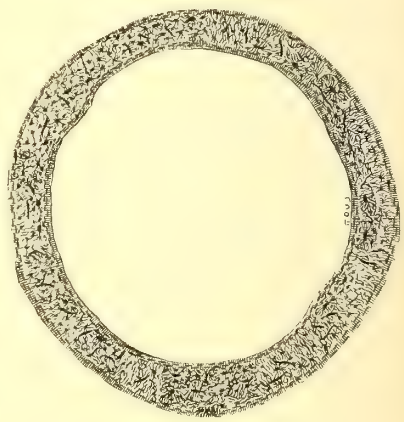

FIG. 112
Right femur of Cathartes aura (turkey-buzzard)

BIRDS

Fig. 113 Right femur of Mormoops

Fig. 114 Right femur of Rhinolophus mehelyi

Fig. 115 Left femur of Sturnira lilium

Fig. 116 Right femur of Lonchorhina

Fig. 117 Left femur of Rousettus amplexicaudatus

Fig. 118 Right femur of Hipposideros larvatus

Fig. 119 Left femur of Hemiderma

Fig. 120 Left femur of Desmodus rotundus

Fig. 121 Left femur of Leptonycteris

Fig. 122 Right femur of Rhinopoma (Palestine)

Fig. 123 Left femur of Erophylla bombifrons

Fig. 124 Left femur of Phyllostoma hastatum

Fig. 125 Left femur of Epomophorus wahlbergii

Fig. 126 Left femur of Glossophaga elongata

Fig. 127 Left femur of Nyctalus aviator

Fig. 128 Left femur of Scotophilus heathii

Fig. 129 Right femur of Miniopterus schreibersii

Fig. 130 Left femur of Promops fosteri

Fig. 131 Left femur of Vespertilio murinus

Fig. 132 Right femur of Molossus nigricans

Fig. 133 Right femur of Dasypterus intermedius

Fig. 134 Left femur of Molossus major

Fig. 135 Left femur of Antrozous pallidus

Fig. 136 Left femur of Eumops californicus

Fig. 137 Right femur of Plecotus auritus

Fig. 138 Left femur of Nycticeius humeralis

Fig. 139 Right femur of Myotis myotis

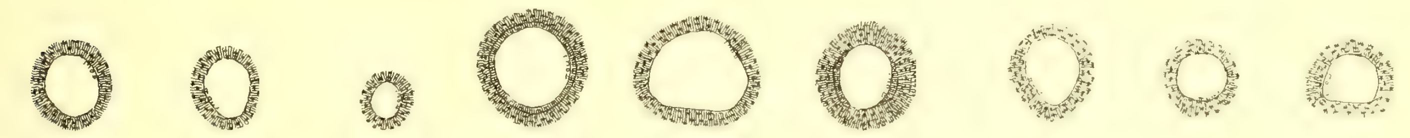

Fig. 140 Left femur of Eptesicus bahamensis

Fig. 141 Left femur of Nycteris borealis

Fig. 142 Right femur of Glischropus tylopus

Fig. 143 Right femur of Nycteris cinerea

Fig. 144 Left femur of Phyllonycteris

Fig. 145 Right femur of Megaderma spasma

Fig. 146 Right femur of Pteronotus

Fig. 147 Left femur of Balantiopteryx plicata

Fig. 148 Right femur of Saccopteryx

Fig. 149 Left femur of Petalia

Fig. 150 Left femur of Monophyllus

Fig. 151 Left femur of Vampyrops lineatus

Fig. 152 Right femur of Chilonycteris

Fig. 153 Right femur of Cynopterus

Fig. 154 Left femur of Artibeus palmarum

Fig. 155 Left femur of Brachyphylla.

Fig. 156 Right femur of Macroglossus minimus

Fig. 157 Left femur of Taphozous philippinensis

Fig. 158 Right femur of Cheiromeles torquatus

Fig. 159 Right femur of Noctilio.

Fig. 160 Left femur of Pteropus molossinus (small)

Fig. 161 Right femur of Pteropus molossinus (large)

Fig. 162 Right femur of Pteropus aldabrensis

Fig. 163 Right femur of Pteropus (Celebes)

Fig. 164 Right femur of Pteropus (Java)

Fig. 165 Right femur of Pteropus lepidus

Fig. 166 Right femur of Pteropus (Tongatabu)

FIFTY GENERA OF BATS


Fig. 167
Right femur of Pteropus poliocephalus (fruit-eating bat)


Fig. 168
Left femur of Tupaia. Tree shrew

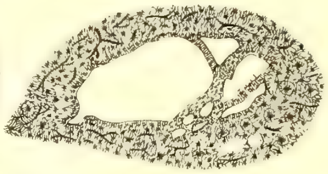
Fig. 169
Right femur of Echidna (egg-laying mammal)

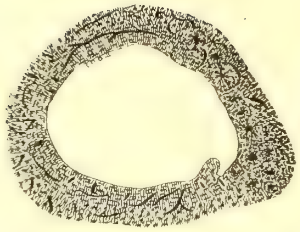
Fig. 170
Left femur of Ornithorhynchus. (duckbill, egg-laying mammal)


Fig. 171
Left femur of Cavia cutleri (guinea-pig)


Fig. 172
Left femur of Scalopus aquaticus (mole)


Fig. 173
Right femur of Sorex (shrew)


Fig. 174
Right femur of Macropus (wallaby)


Fig. 175
Left femur of Solenodon paradoxus (young)

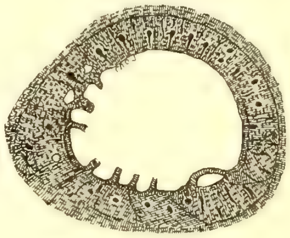
Fig. 176
Right femur of Solenodon paradoxus (adult)


Fig. 177
Femur of Lemur mongoz

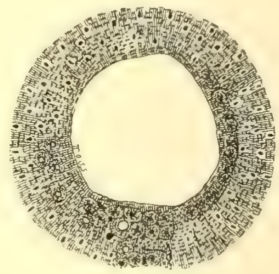
Fig. 178
Left femur of Colobus abyssinicus caudatus (African monkey)

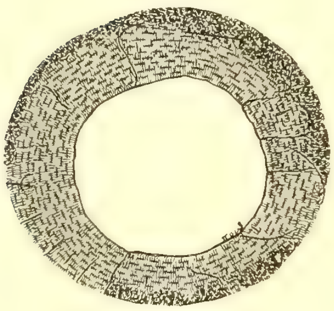
Fig. 179
Femur of Putorius vulgaris (weasel)

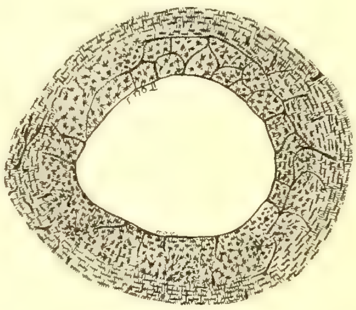
Fig. 180
Right femur of Mus rattus (black rat)

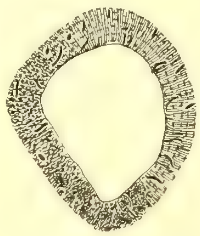
Fig. 181
Left femur of Heteromys (Spiny pocket rat)

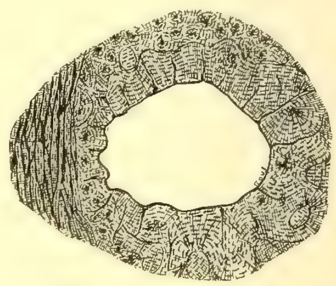
Fig. 182
Right femur of Myogale moschata (desman)


Fig. 183
Femur of Cynomys ludovicianus (prairie dog)


Fig. 184
Left femur of Trichosurus vulpecula (phalanger)

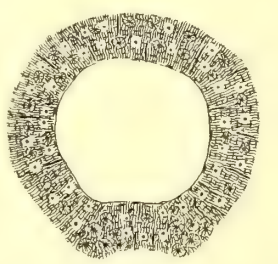
Fig. 185
Left femur of Phascolomys ursinus (wombat)

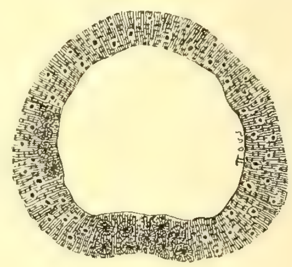
Fig. 186
Right femur of Lasiopyga kolbi


FIG. 187
Right femur of Tragulus javanicus (mouse-deer)

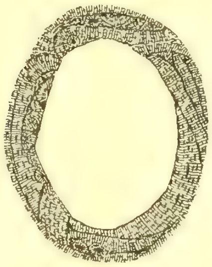
FIG. 188
Right femur of Mus sylvaticus (wood mouse)

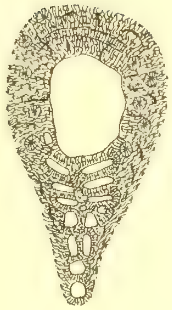
FIG. 189
Left femur of Erinaceus europæus (hedgehog)


FIG. 190
Right femur of Viverra Civet


FIG. 191
Right femur of Ratufa maxima (giant squirrel)

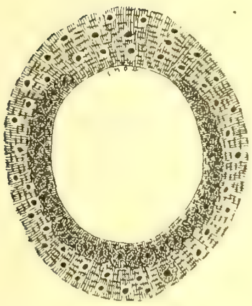
FIG. 192
Femur of Galeopithecus (flying lemur)

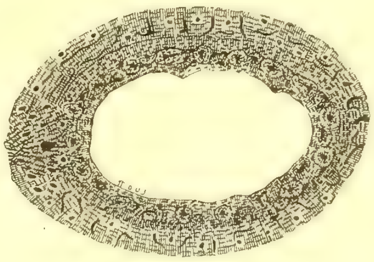
FIG. 193
Left femur of Manis (scaly ant-eater)


FIG. 194
Right femur of Procavia capensis (coney)


FIG. 195
Left femur of Helictis orientalis (asiatic badger)


FIG. 196
Right femur of Cynocephalus (baboon)


FIG. 197
Right femur of Cynocephalus maimon (mandrill)

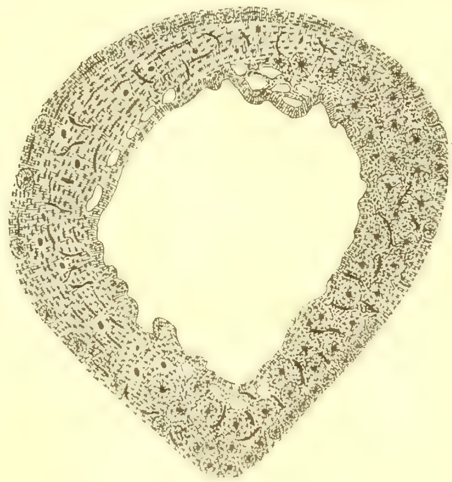
FIG. 198
Right femur of Hydrochœrus capybara

MAMMALS

Fig. 199
Right femur of a fetal sheep (eleven weeks)

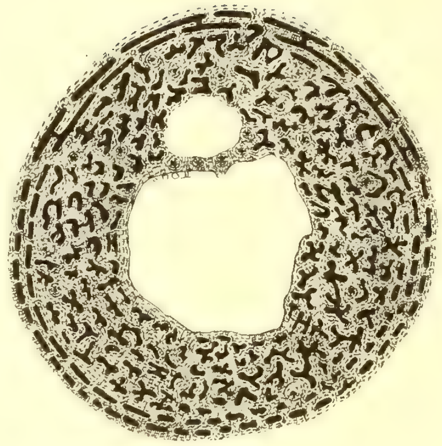

Fig. 200
Right femur of a fetal calf (eighteen weeks)

Fig. 201
Right femur of a fetal pig (eight and one-half weeks)

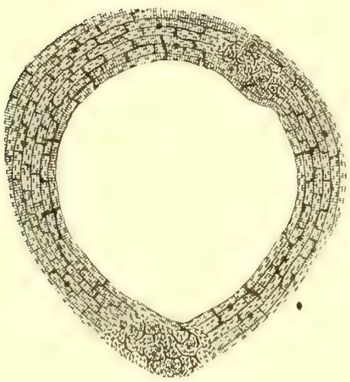

Fig. 202
Femur of Cariacus macrotis (deer)

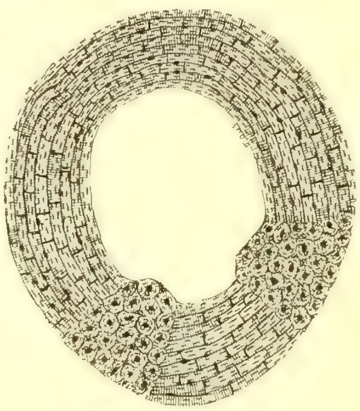

Fig. 203
Right femur of Sus (domestic pig)

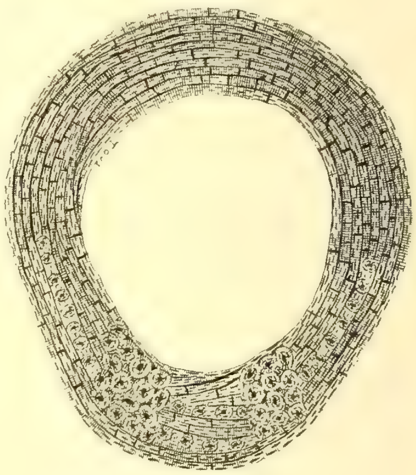

Fig. 204
Right femur of Sus scrofa (wild boar)

Fig. 205
Femur of Alces machlis (elk)

Fig. 206
Right femur of Camelus (camel)

Fig. 207
Right femur of Auchenia glama (llama)

Fig. 208
Right femur of Rangifer (reindeer)

MAMMALS

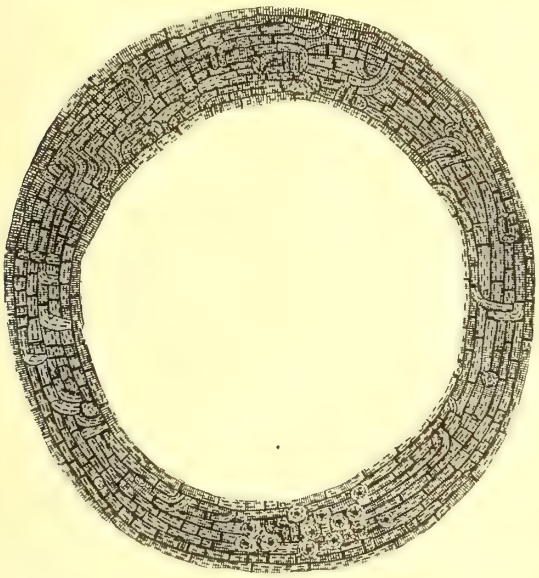

Fig. 209
Left femur of Ursus americanus (black bear)

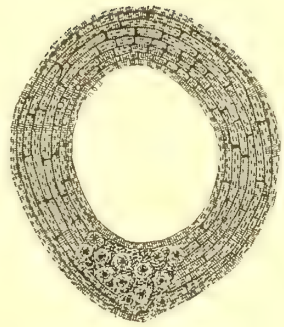

Fig. 210
Right femur of Taurotragus (eland)

Fig. 211
Left femur of Connochætes taurinus albojubatus (gnu)

Fig. 212
Right femur of Ovibos moschatus wardi (musk ox)

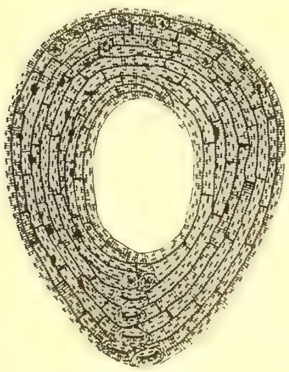

Fig. 213
Right femur of a Mexican burro

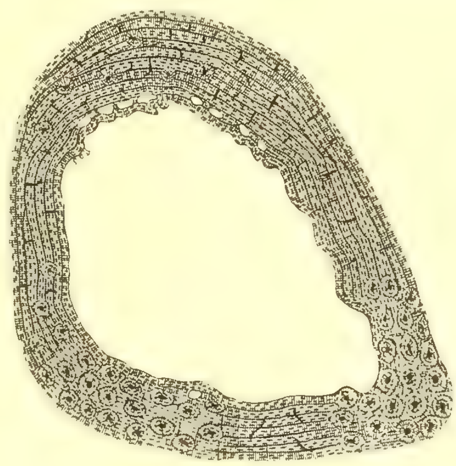

Fig. 214
Right femur of Tapirus (tapir)

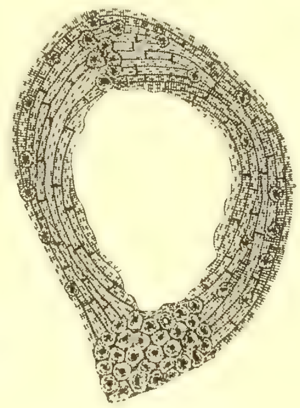

Fig. 215
Right femur of Equus hemionus (wild ass of Asia)

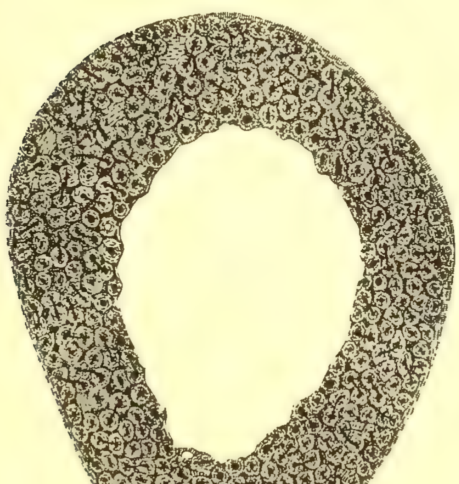

Fig. 216
Right femur of Elephas africanus (African elephant)

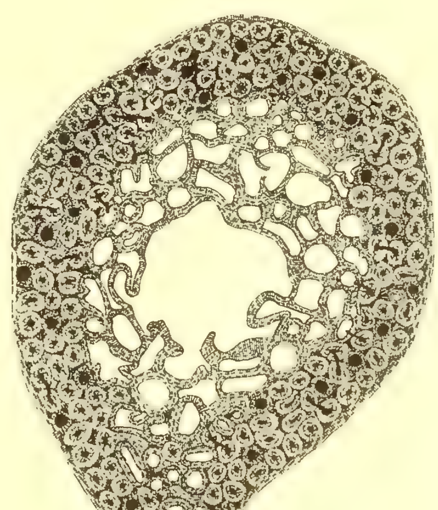

Fig. 217
Femur of Cholœpus didactylus (two-toed sloth)

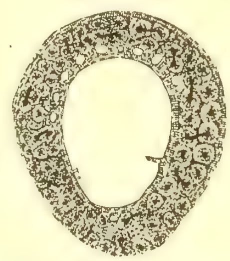

Fig. 218
Right femur of Potos caudivolvulus (kinkajou)

Fig. 219
Right femur of Lutra canadensis (otter)

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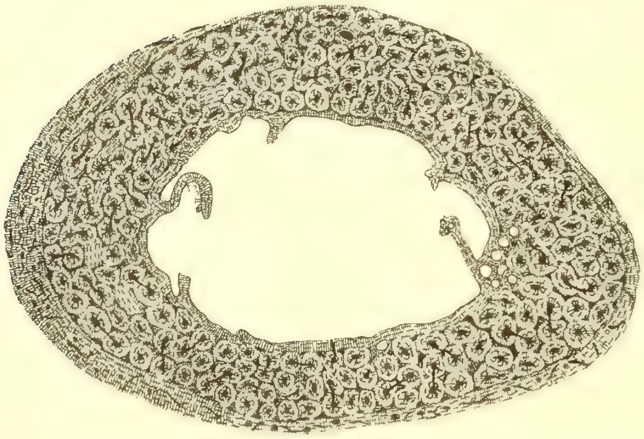
Fig. 220
Right femur of Simia satyrus (orang-utan)

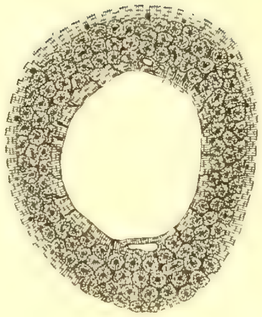
Fig. 221
Left femur of Felis tigris (tiger)

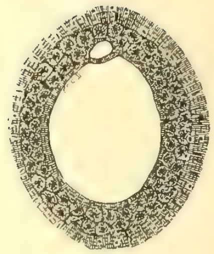
Fig. 222
Right femur of Hemigalus hardwickii

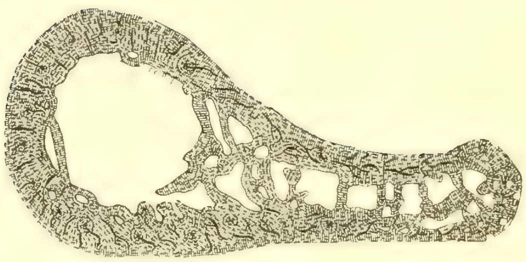
Fig. 223
Right femur of Tatu novemcinctus. Armadillo

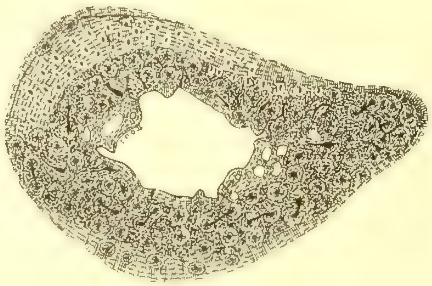
Fig. 224
Right femur of Tamandua tetradactyla (ant-eater)

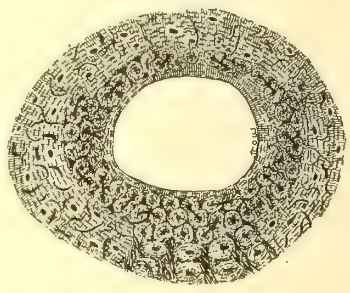
Fig. 225
Left femur of Gorilla (gorilla)


Fig. 226
Femur of Presbytis rubicunda (monkey)

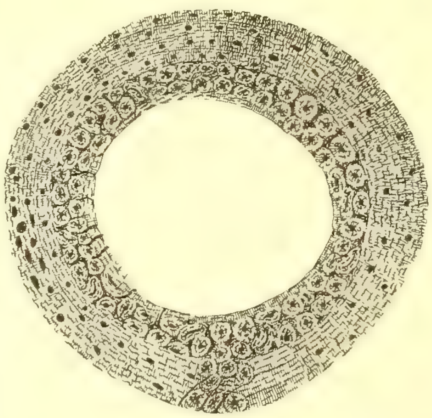
Fig. 227
Right femur of Hylobates (gibbon)

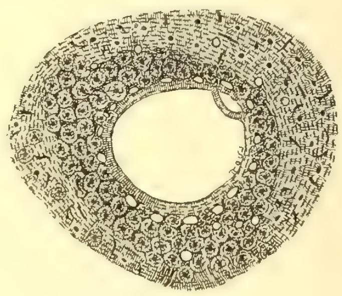
Fig. 228
Left femur of Anthropopithecus troglodytes (chimpanzee)

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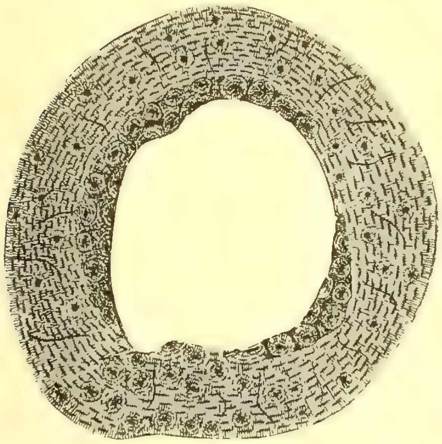
FIG. 229
Right femur of Macacus rhesus (Indian monkey)

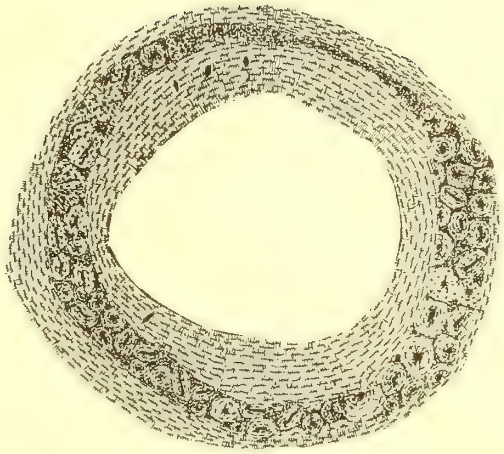
FIG. 230
Right femur of Sciurus sp. (large red squirrel)

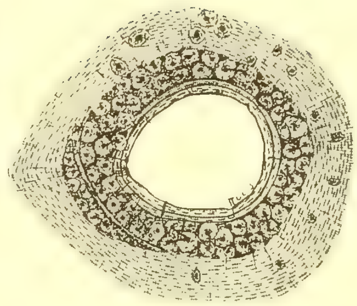
FIG. 231
Right femur of Felis (domestic cat)

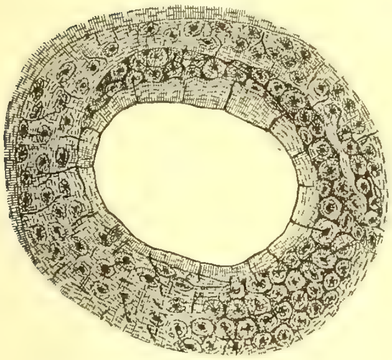
FIG. 232
Left femur of Felis catus (wildcat)


FIG. 233
Femur of Mephitis mephitica (skunk)

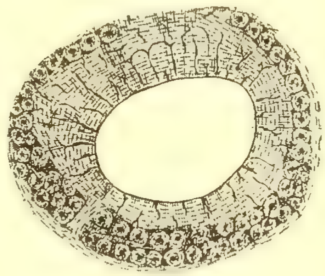
FIG. 234
Femur of Putorius vison (mink)


FIG. 235
Left femur of
Cryptoprocta ferox
(catlike civet)

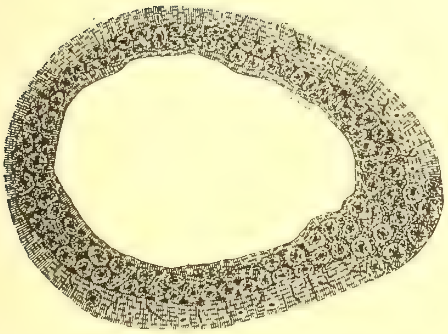
FIG. 236
Right femur of Hyæna crocuta (Hyæna)

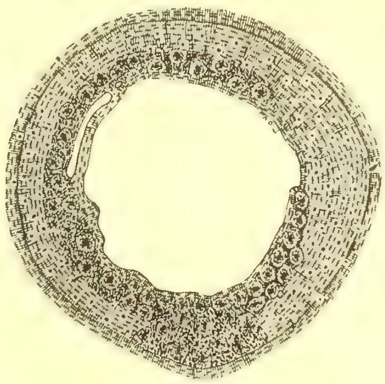
FIG. 237
Right femur of Thylacinus cynocephalus
(Tasmanian wolf)


FIG. 238
Right femur of Dasyprocta
agouti


FIG. 239
Left femur of Lasiopyga
centralis johnstoni (monkey)

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FIG. 240
Right femur of Felis canadensis (Canada lynx)

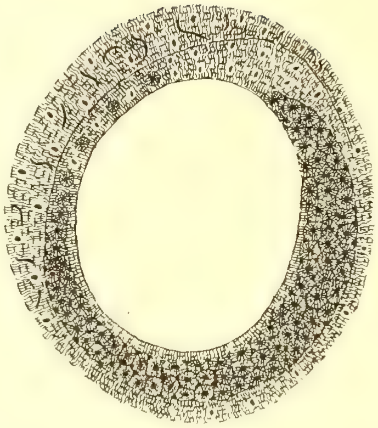

FIG. 241
Right femur of Lasiopyga sp. (African monkey)

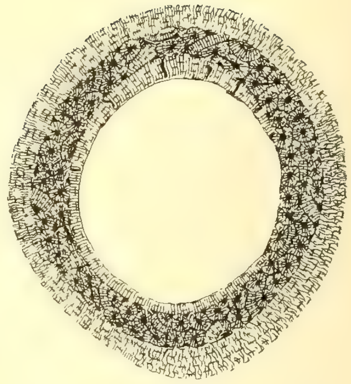

FIG. 242
Right femur of Midas rufoniger (South American monkey)

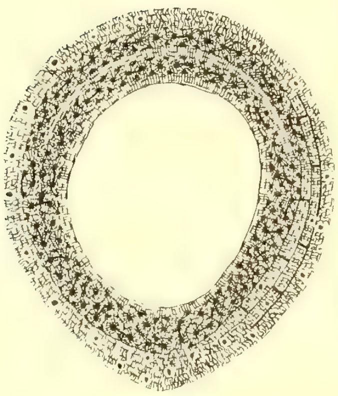

FIG. 243
Left femur of Lemur variegatus

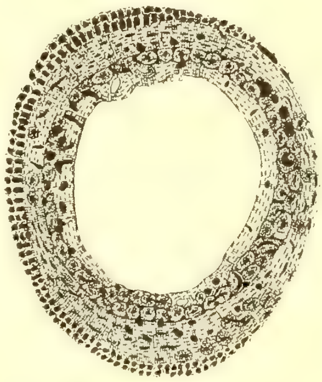

FIG. 244
Right femur of Lemur catta (ring-tailed lemur)

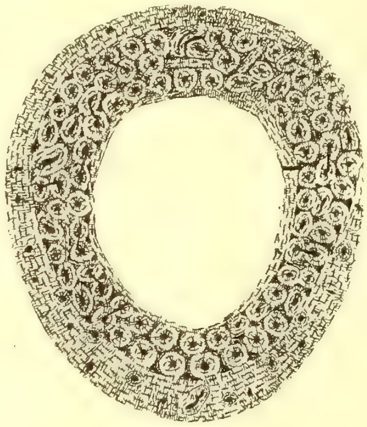

FIG. 245
Left femur of Ateles (spider-monkey) (Tehuantepec)

FIG. 246
Right femur of Callicebus torquatus (squirrel-monkey)

FIG. 247
Left femur of Genetta (genet)

FIG. 248
Left femur of Pedetes (jumping hare)

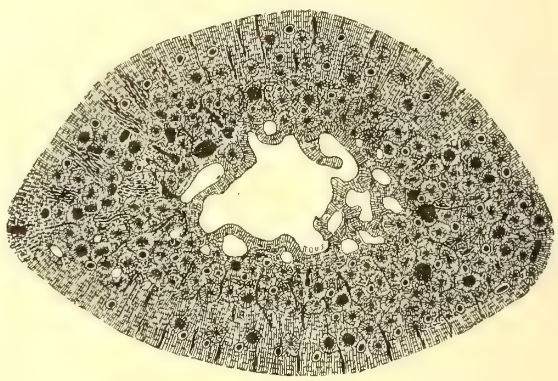

FIG. 249
Right femur of Bradypus tridactylus (three-toed sloth)

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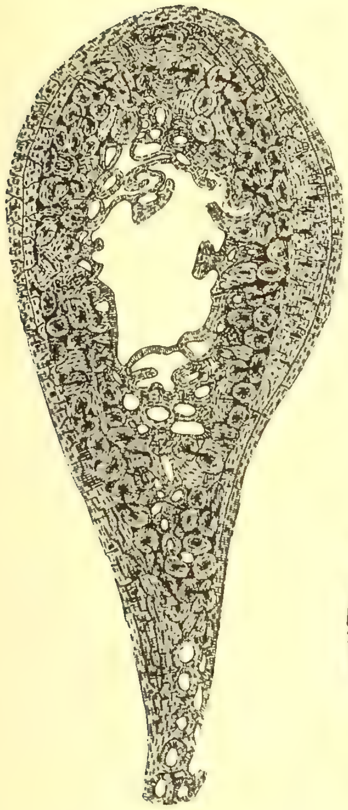

Fig. 250
Right femur of Castor canadensis (beaver)

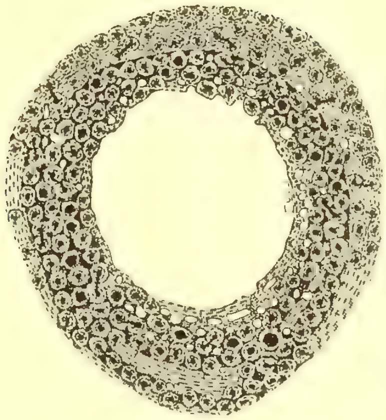

Fig. 251
Left femur of Felis pardus (leopard)

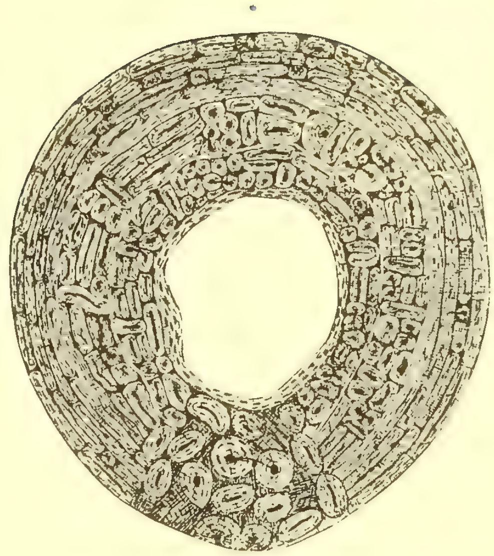

Fig. 252
Left femur of Bos (ox)

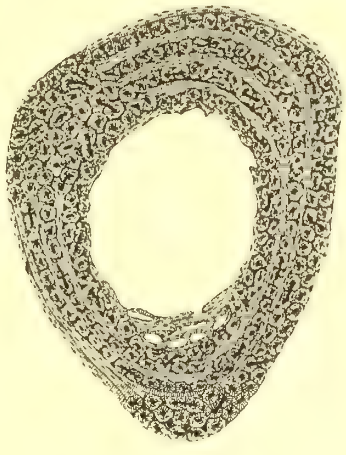

Fig. 253
Left femur of Equus caballus (horse)

Fig. 254
Right femur of Ovis (sheep)

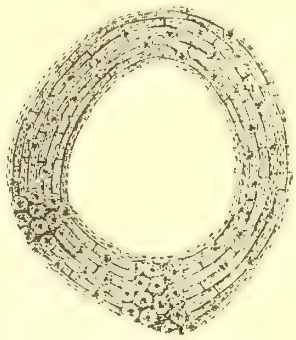

Fig. 255
Right femur of Bison americanus (bison)

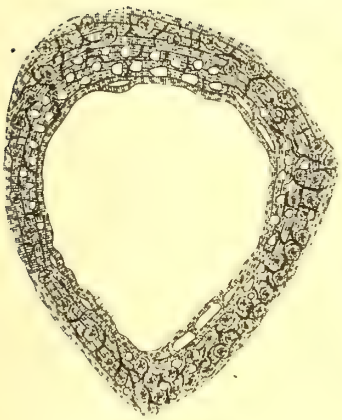

Fig. 256
Right femur of a mule. No. 227, C. M. C.

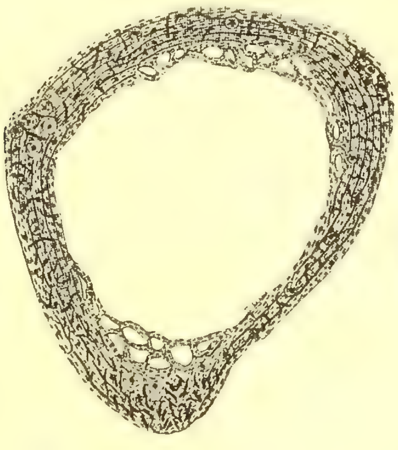

Fig. 257
Left femur of a mule. No. 229 C. M. C.

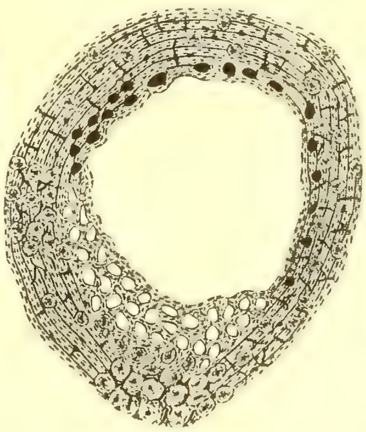

Fig. 258
Left femur of a mule. No. 235, C. M. C.

Fig. 259
Left femur of a mule. No. 236, C. M. C.

MAMMALS

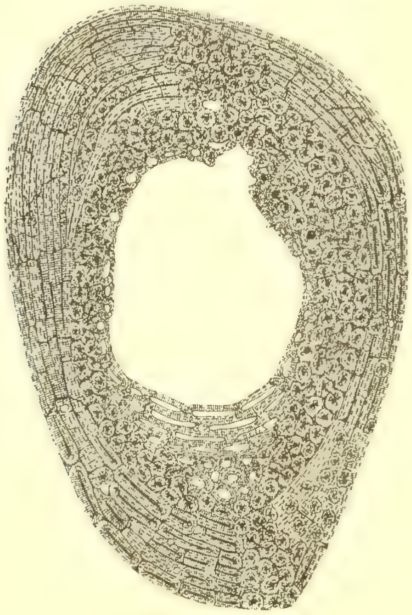

Fig. 260
Left femur of Elephas indicus (Asiatic elephant)

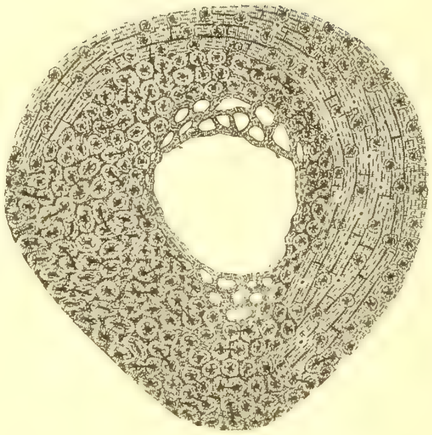

Fig. 261
Right femur of Hippopotamus amphibius (hippopotamus)

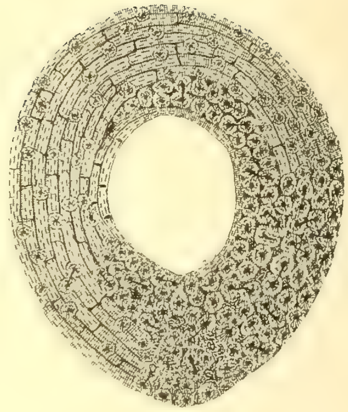

Fig. 262
Left femur of Giraffa camelopardalis (giraffe)

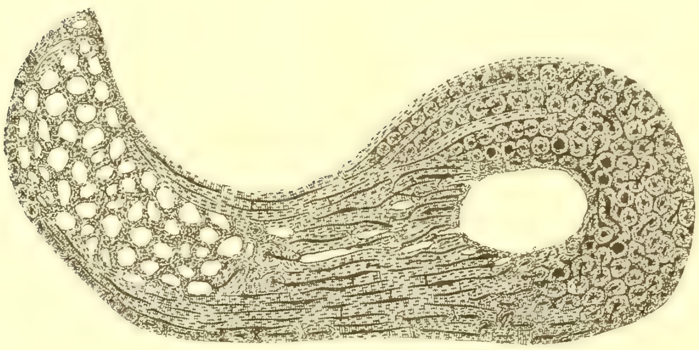

Fig. 263
Left femur of Rhinoceros bicornis (rhinoceros)

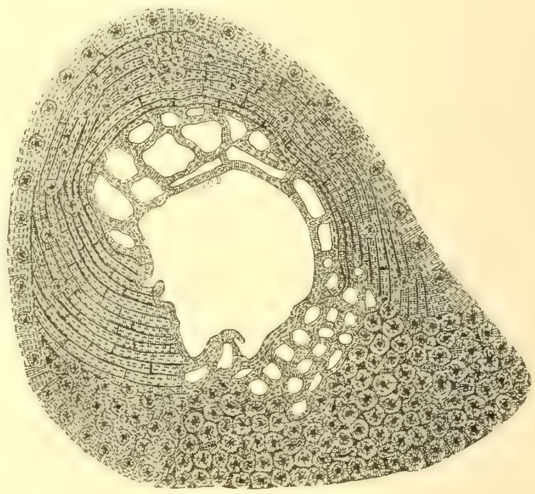

Fig. 264
Right femur of Equus burchelli (zebra)

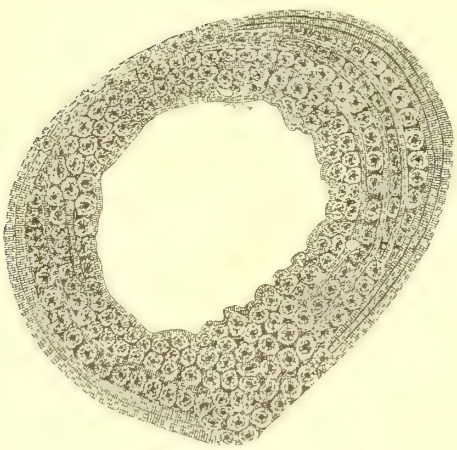

Fig. 265
Left femur of Ursus maritimus (polar bear)

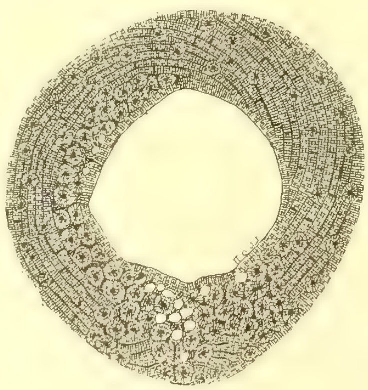

Fig. 266
Right femur of Bubalis jacksoni (Hartebeest)

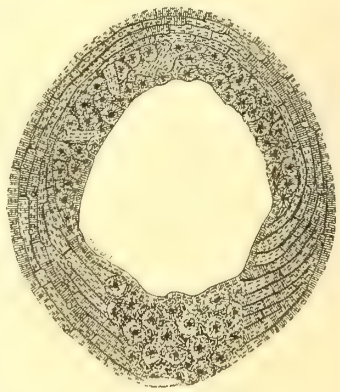

Fig. 267
Left femur of Phacochœrus (wart-hog)

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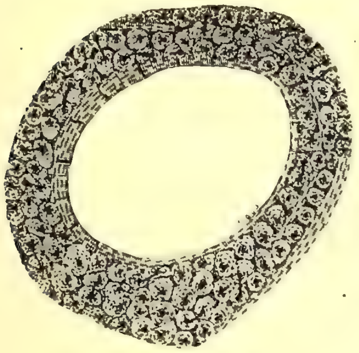

Fig. 268
Left femur of Felis concolor (panther)

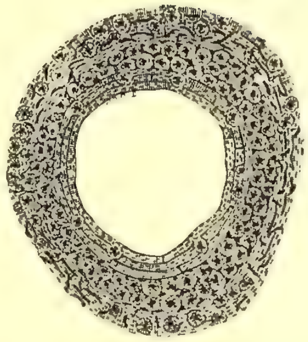

Fig. 269
Left femur of Gulo luscus (wolverene)

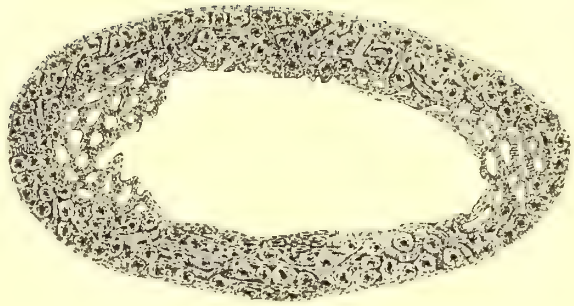

Fig. 270
Left femur of Erignathus barbatus (seal)

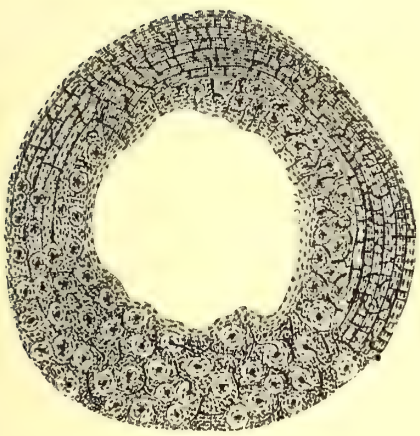

Fig. 271
Left femur of Bos bubalis (water buffalo)

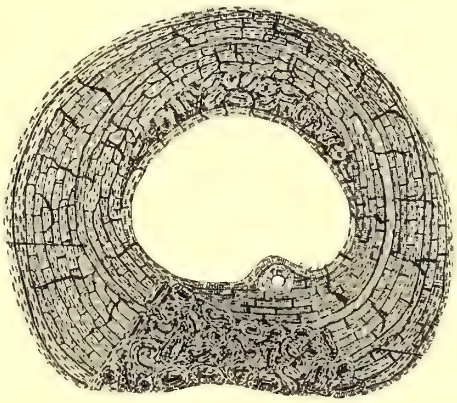

Fig. 272
Left femur of Ovis montana (mountain sheep)

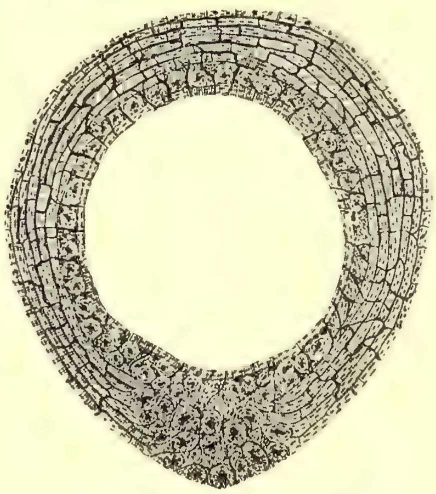

Fig. 273
Femur of Cephalophus (African antelope)

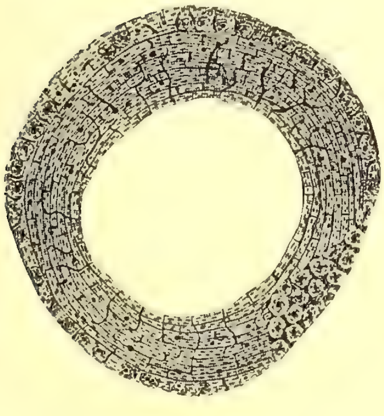

Fig. 274
Femur of Raphiceros (steinbok)

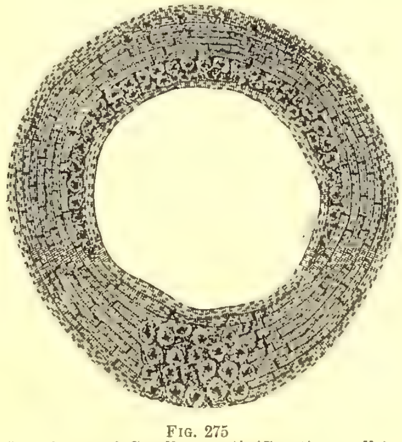

Fig. 275
Left femur of Gazella granti (Grant's gazelle)

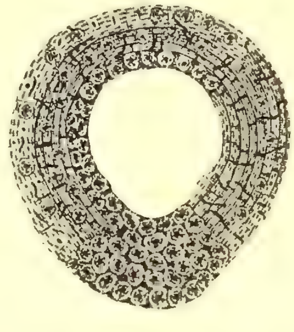

Fig. 276
Left femur of Kobus ellipsiprymnus (water buck)

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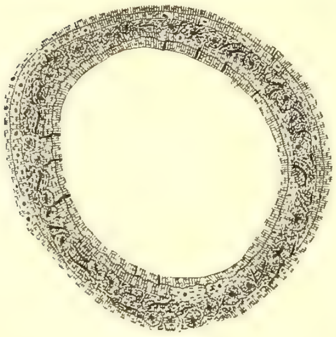

Fig. 277
Right femur of Arctomys monax (woodchuck)

Fig. 278
Right femur of Canis latrans (coyote)

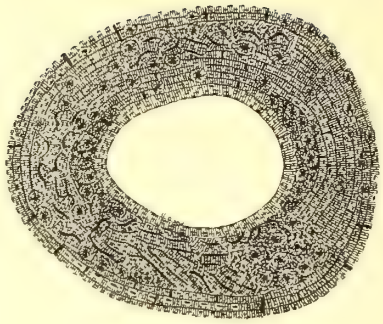

Fig. 279
Right femur of Capra (goat)

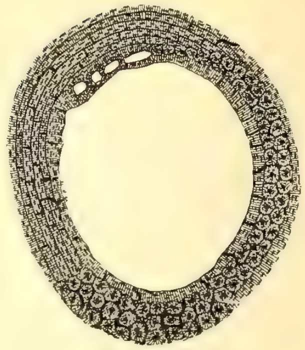

Fig. 279½
Right femur of a bull-dog (not a pure blood)

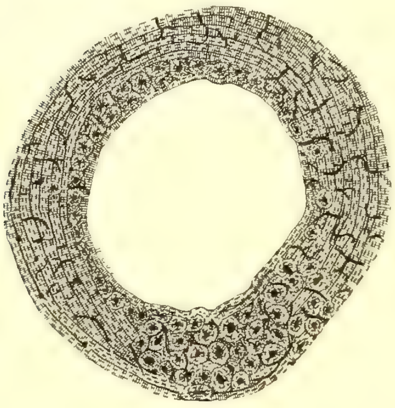

Fig. 280
Left femur of a shepherd dog (not a pure blood)

Fig. 280½
Right femur of a dog

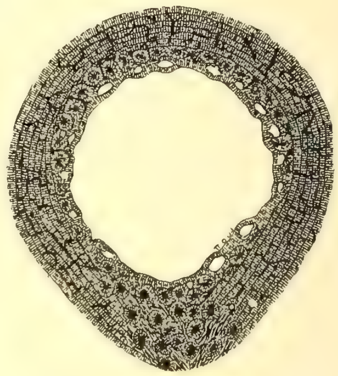

Fig. 281
Femur of a fox terrier (not a pure blood)

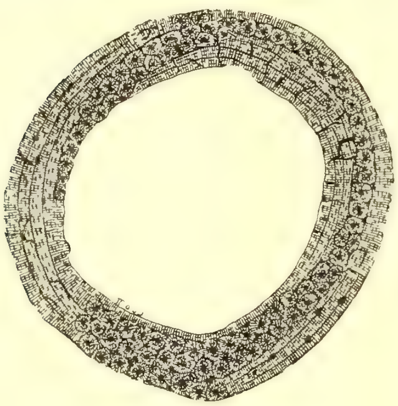

Fig. 282
Right femur of a mongrel dog

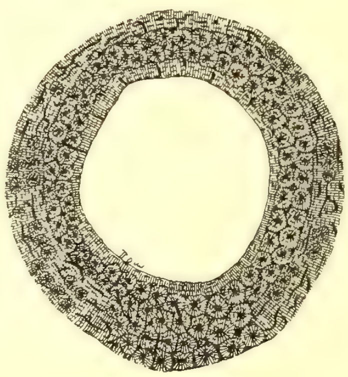

Fig. 283
Right femur of a bull dog (not a pure blood)

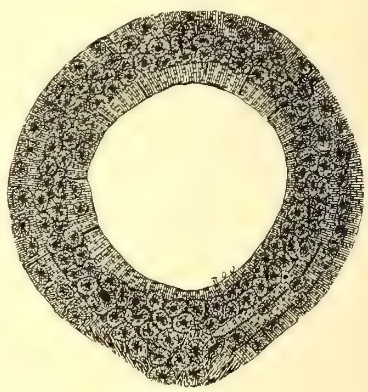

Fig. 284
Right femur of a collie dog (not a pure blood)

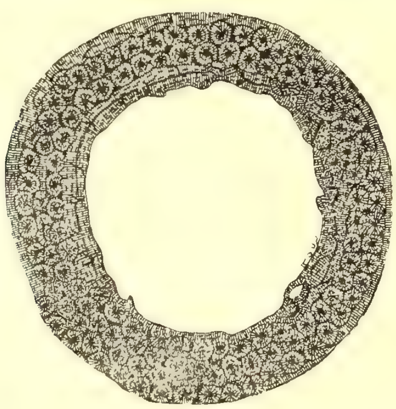

Fig. 285
Right femur of a spaniel (not a pure blood)

Fig. 286
Left femur of Lepus cuniculus (rabbit)

MAMMALS

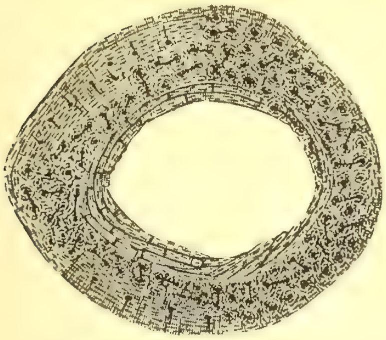

FIG. 287
Right femur of Procyon lotor (raccoon)

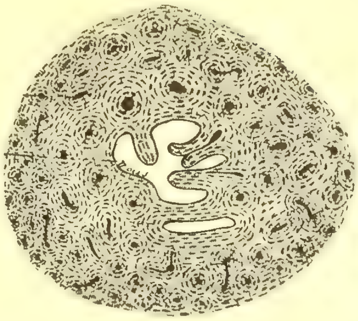

FIG. 288
Os penis of Raccoon

FIG. 289
Femur of Canis lupus
(grey wolf)

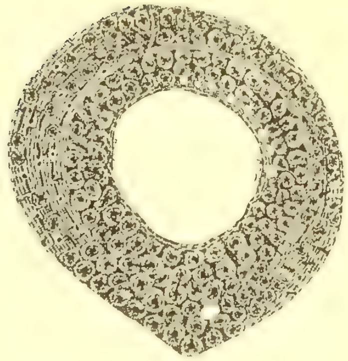

FIG. 290
Right femur of a Felis leo (lion)

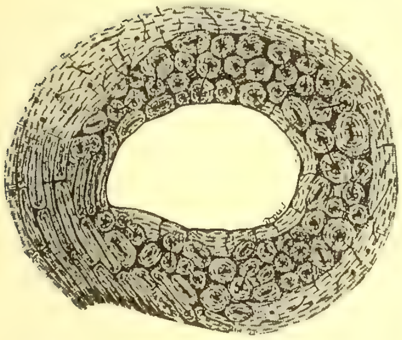

FIG. 291
Right femur of Canis (small grey fox)

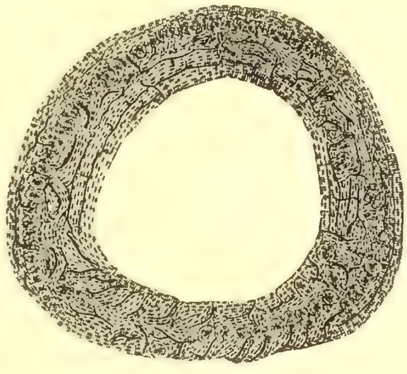

FIG. 292
Left femur of Taxidea americana (American badger)

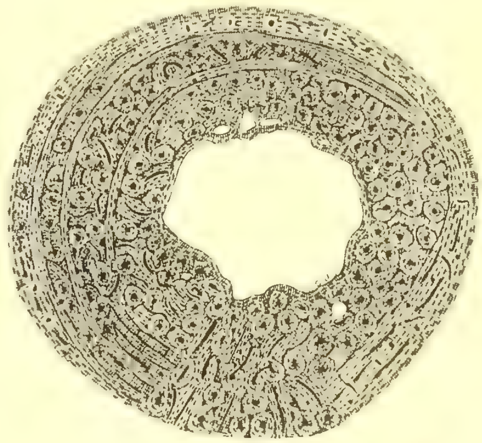

FIG. 293
Right femur of Melursus labiatus (sloth bear)

FIG. 295
Right femur of Didelphis virginiana (opossum)

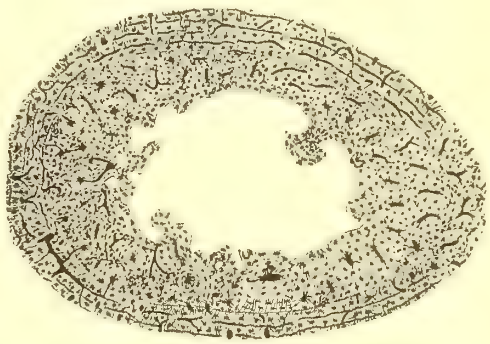

FIG. 296
Left femur of Manis (scaly ant-eater)

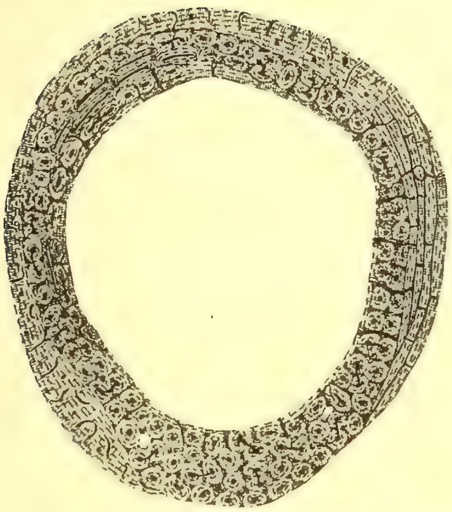

FIG. 294
Left femur of Canis aureus (jackal)

FIG. 297
Right femur of Haplondontia olympica,
sewellel (mountain beaver)

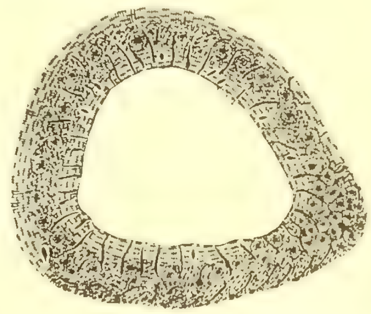

FIG. 298
Left femur of a Erethizon (porcupine)

MAMMALS

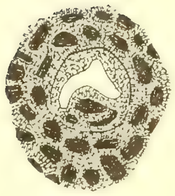

FIG. 299
Right femur of a white fetus of 2-2½ months

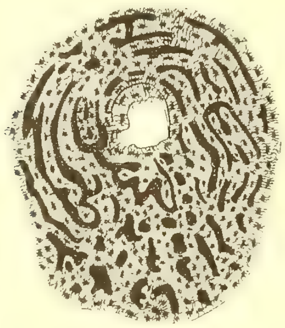

FIG. 300
Right femur of a white fetus of 3-3½ months

FIG. 301
Right femur of a white fetus of 4 months

FIG. 302
Right femur of a white fetus of 5-7 months

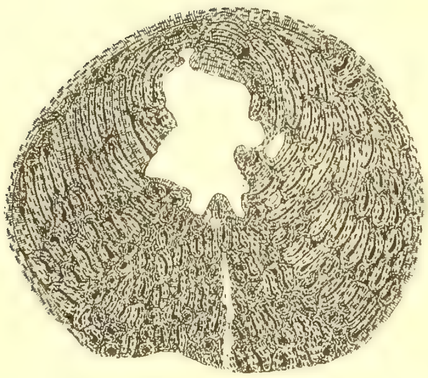

FIG. 303
Right femur of a white fetus of 8-9 months

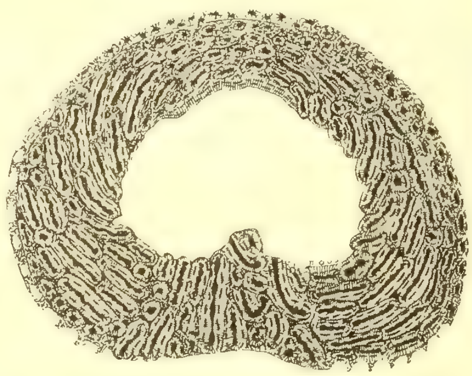

FIG. 304
Right femur of negro fetus of 9 months

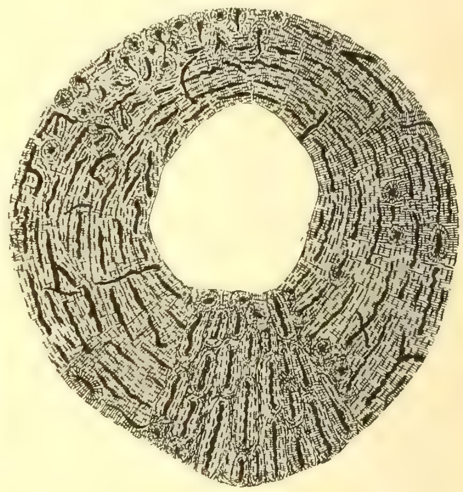

FIG. 305
Right femur of white fetus of 8½ months (Craniorrhachischisis)

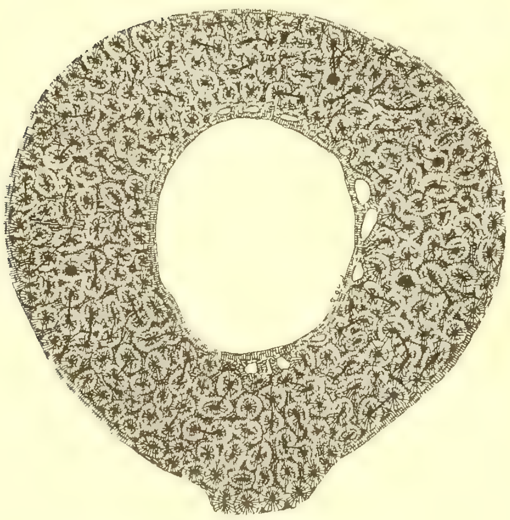

FIG. 306
Left femur of a negro. No. 228481, U. S. N. M.

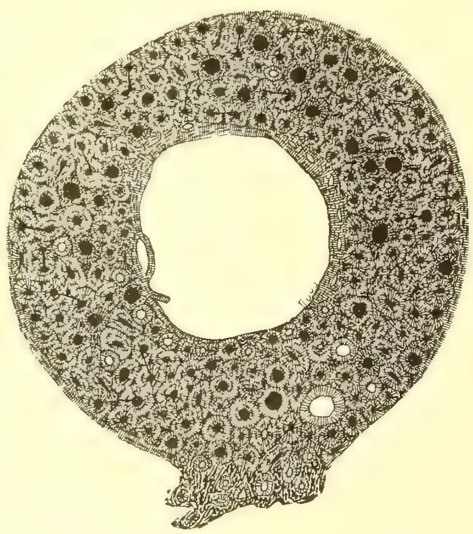

FIG. 307
Femur of mixed negro and white (half white). No. 247368, U. S. N. M.

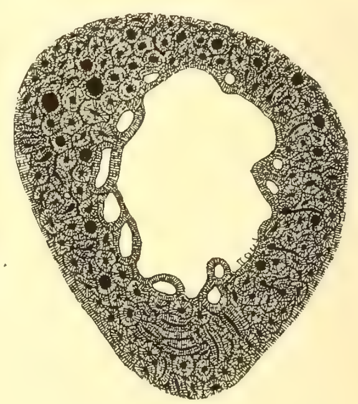

FIG. 308
Left femur of a negro. No. 3, Med. Dept., Tulane Univ.

MAN (WHITE, BLACK)

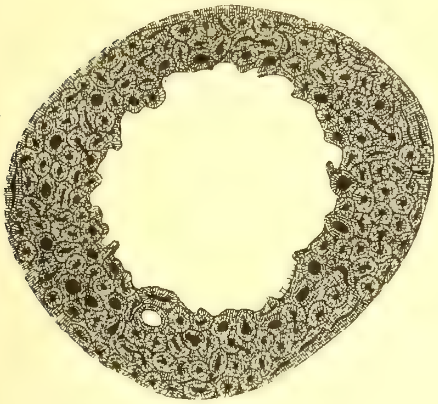

FIG. 309
Left femur of a negro. No. 87, M. D. T. U.

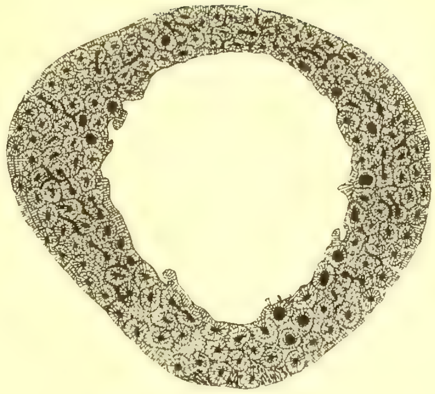

FIG. 310
Right femur of a negro. No. 7, M. D. T. U.

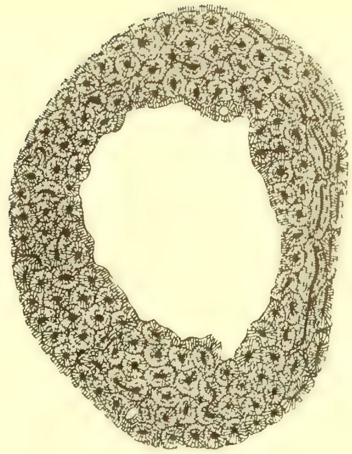

FIG. 311
Left femur of a negro. No. 4, M. D. T. U.

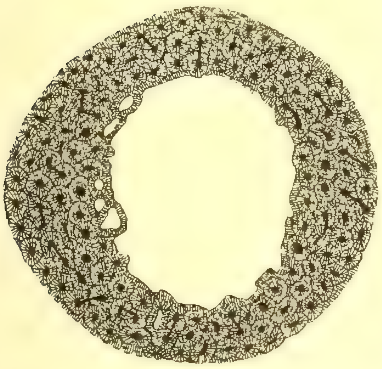

FIG. 312
Right femur of a negro. No. 84, M. D. T. U.

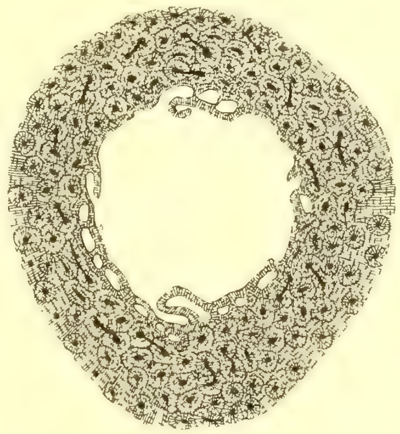

FIG. 313
Left femur of a negro. No. 10, M. D. T. U.

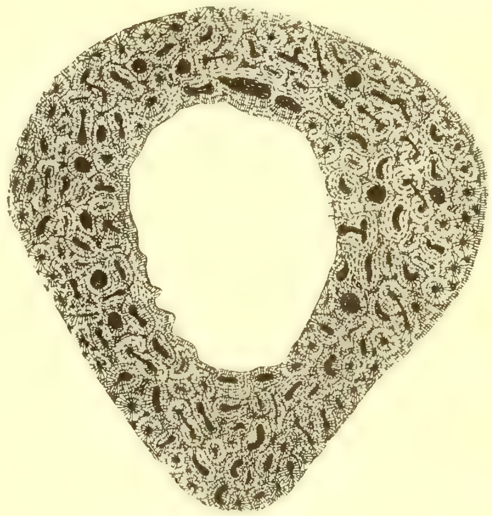

FIG. 314
Right femur of a negress, age 40. No. 123, M. D. T. U.

FIG. 315
Left femur of a negro. No. 79, M. D. T. U.

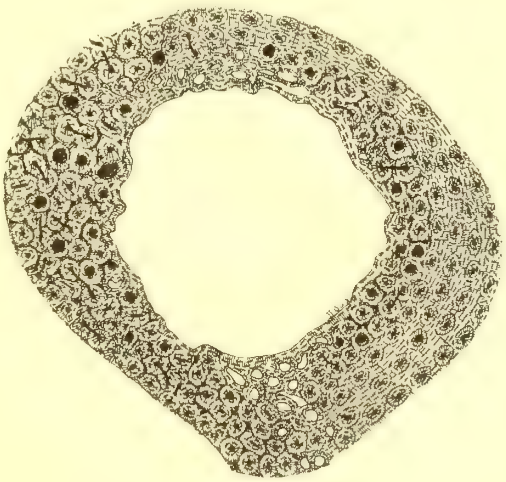

FIG. 316
Left femur of a negro. No. 224714, U. S. N. M.

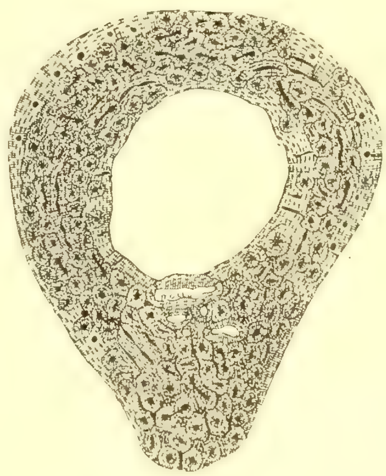

FIG. 317
Left femur of a negro. No. 11, M. D. T. U.

MAN (BLACK)

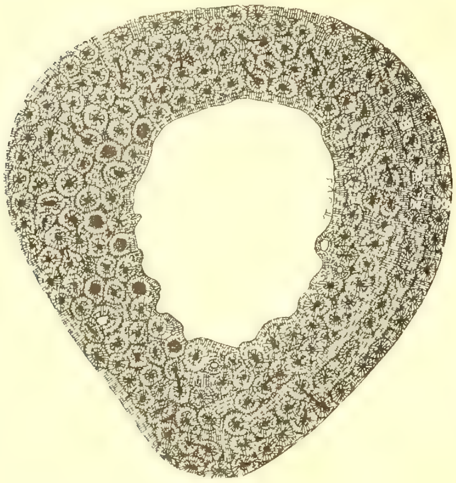

Fig. 318
Right femur of a negro. No. 2, M. D. T. U.

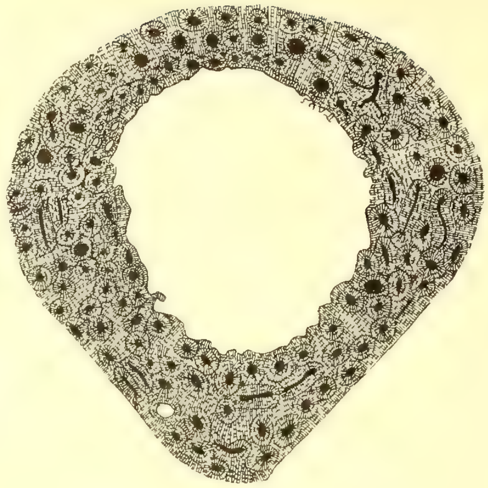

Fig. 319
Left femur of a negro. No. 56, M. D. T. U.

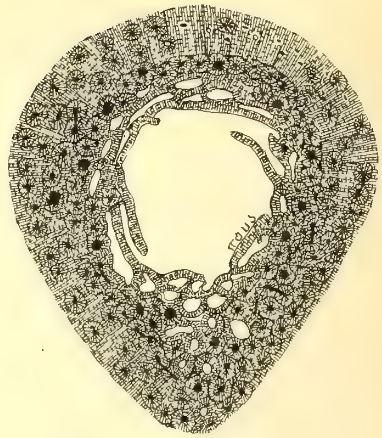

Fig. 320
Left femur of a negress. No. 220, C. M. C.

Fig. 321
Right femur of a negress. No. 220, C. M. C.
Amputated at lower third

Fig. 322
Left femur of a negress age 14,
mixed black and white.
No. 226, C. M. C.

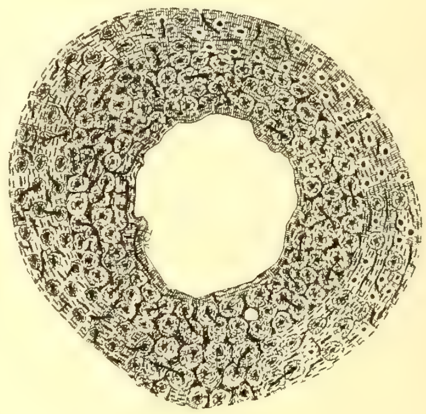

Fig. 323
Femur of a negro. No. 1, M. D. T. U.

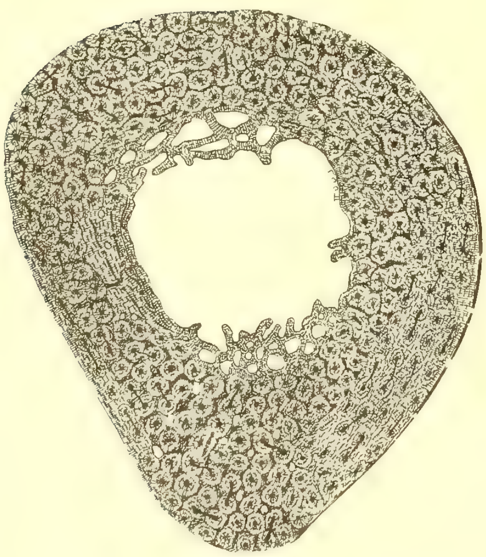

Fig. 324
Right femur of a Kaffir negro. No. 263196, U. S. N. M.

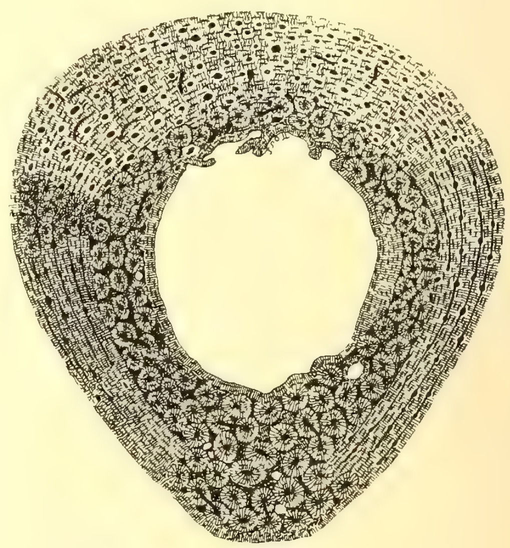

Fig. 325
Right femur of a negro. No. 248674, U. S. N. M.

MAN (BLACK)

Fig. 326
Left femur of a negro. No. 248674, U. S. N. M.

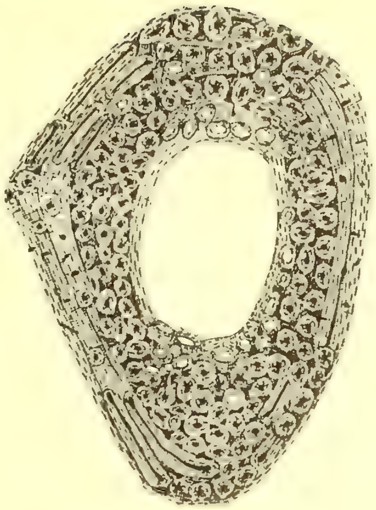

Fig. 327
Tibia of a negro. No. 248674, U. S. N. M.

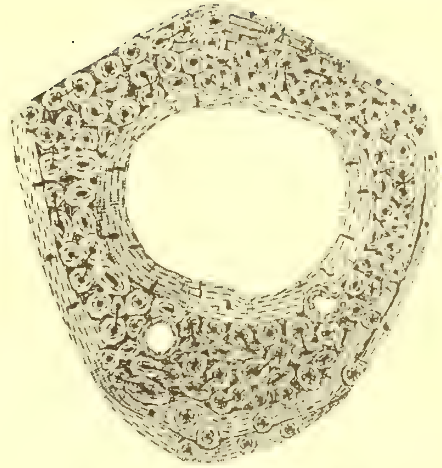

Fig. 328
Fibula of a negro. No. 248674, U. S. N. M.

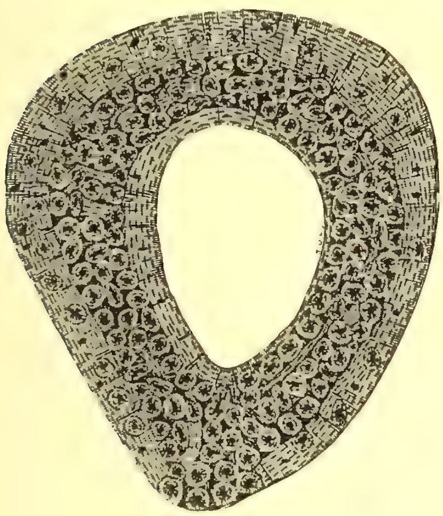

Fig. 329
Ulna of a negro. No. 248674, U. S. N. M.

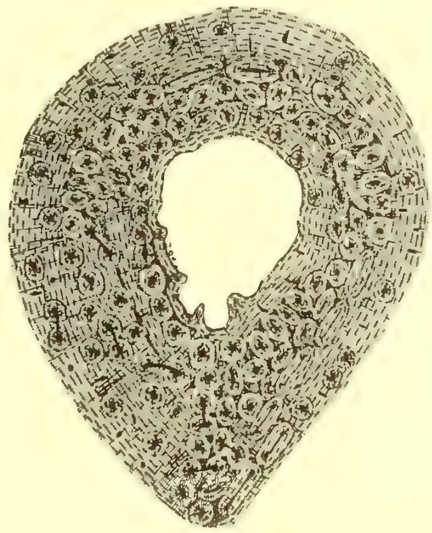

Fig. 330
Radius of a negro. No. 248674, U. S. N. M.

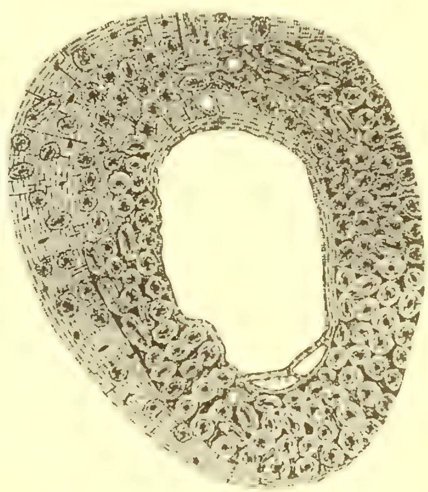

Fig. 331
Humerus of a negro. No. 248674, U. S. N. M.

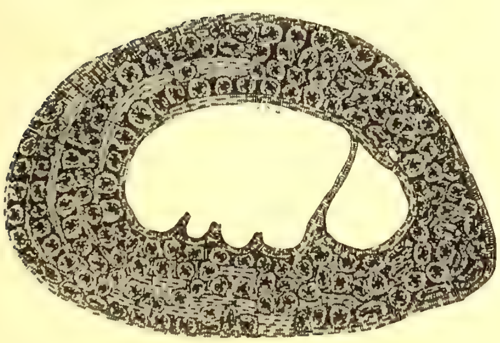

Fig. 332
Clavicle of a negro. No. 248674, U. S. N. M.

Fig. 333
Metatarsal bone of great toe of negro.
No. 248674, U. S. N. M.

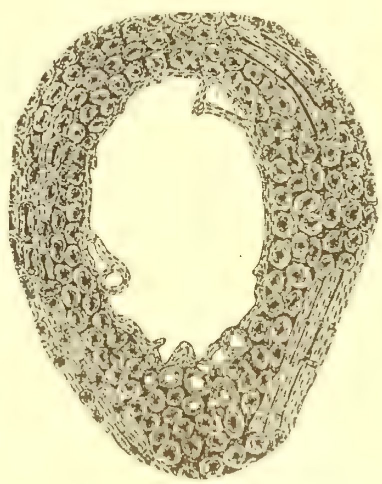

Fig. [illegible]
Left femur of negro. [illegible] 224713, U. S. N. M.

MAN (BLACK)

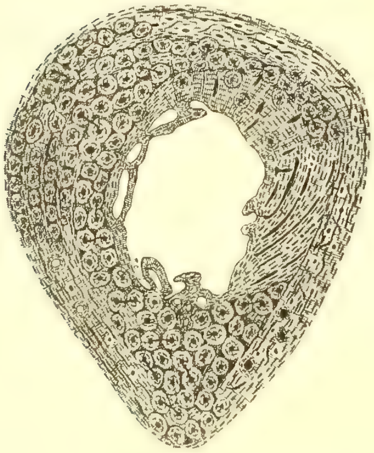

FIG. 335
Right femur of a negro. No. 83, M. D. T. U.

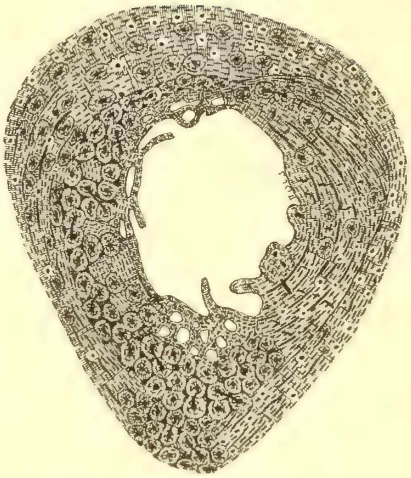

FIG. 336
Right femur of a negro. No. 6, M. D. T. U.

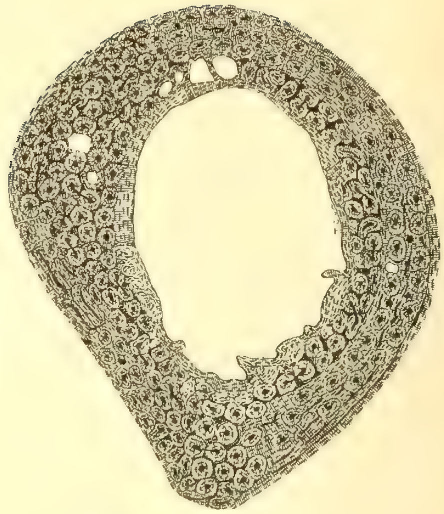

FIG. 337
Right femur of a negro. No. 63, M. D. T. U.

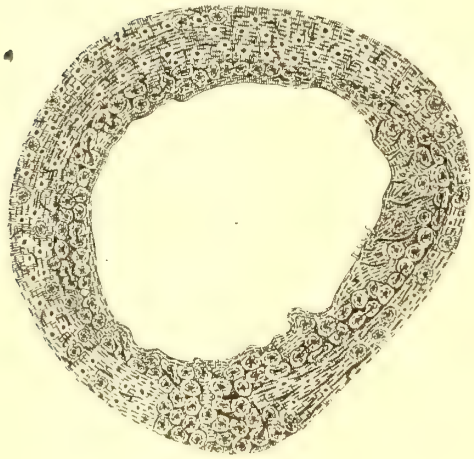

FIG. 338
Left femur of a negro. No. 5, M. D. T. U.

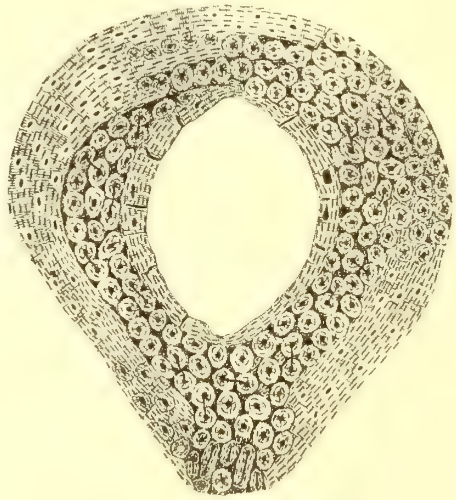

FIG. 339
Right femur of a negro. No. 8, M. D. T. U.

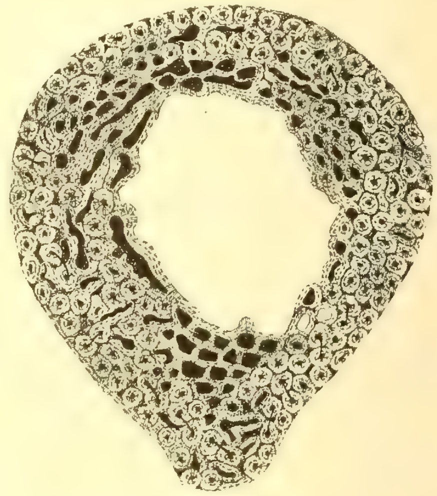

FIG. 340
Left femur of a negro. No. 7, M. D. T. U.

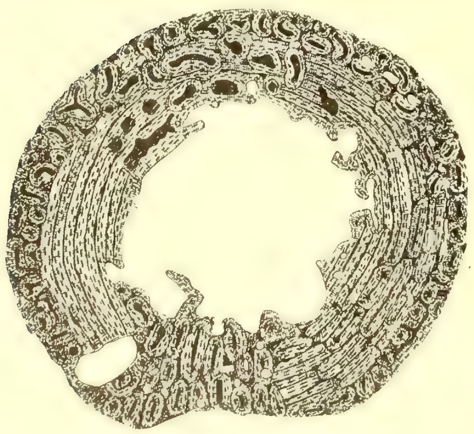

FIG. 341
Right femur of Pueblo Indian child one year old. No. 258675(z) U. S. N. M.

FIG. 342
Left femur of Pueblo Indian child six years old. No. 258675(L), U. S. N. M.

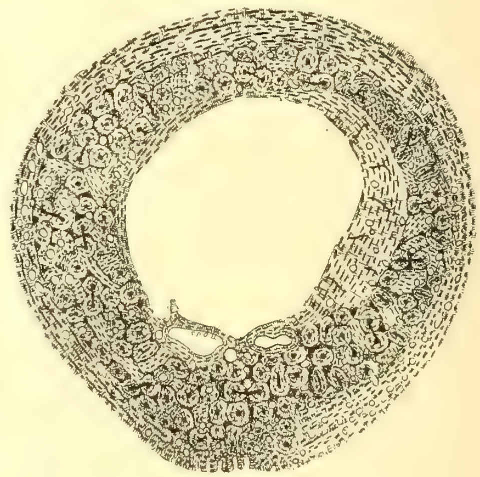

FIG. 342½
Left femur of Pueblo Indian youth. No. 258675(S2), U. S. N. M.

NEGRO. PUEBLO INDIAN.

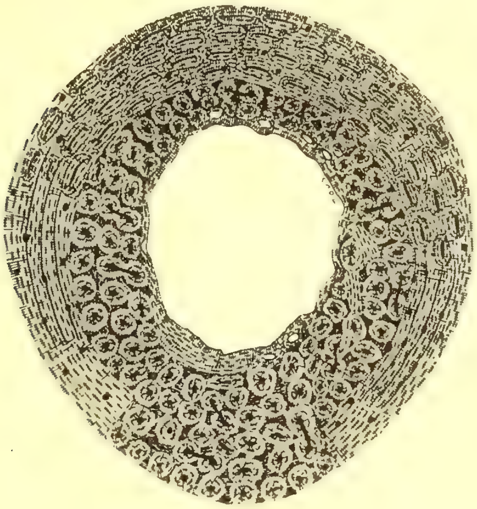

Fig. 343
Femur of Pueblo Indian adult. No. 258675(x) U. S. N. M.

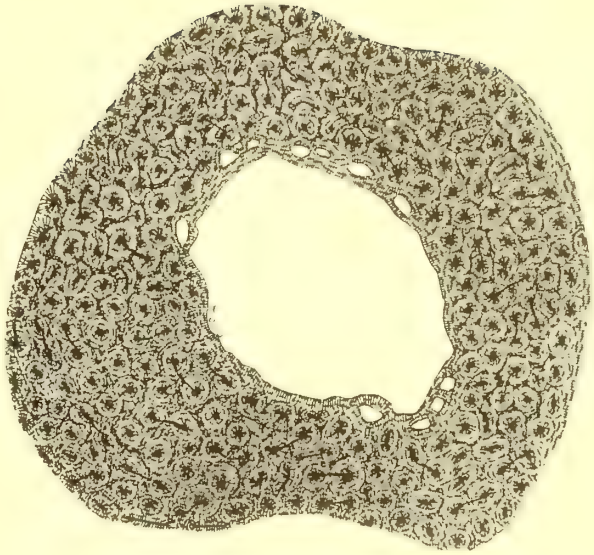

Fig. 344
Right femur of Pueblo Indian adult. No. 227339, U. S. N. M.

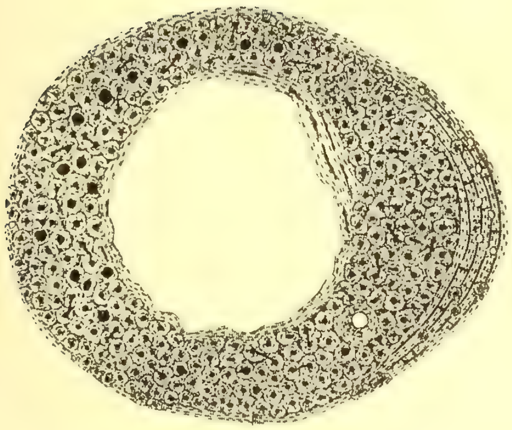

Fig. 345
Left femur of Peruvian Indian. No. 266469(b), U. S. N. M.

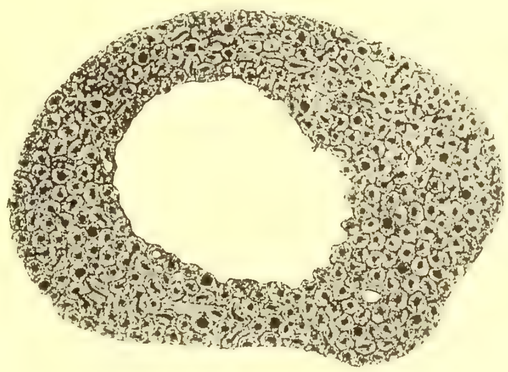

Fig. 346
Left femur of Peruvian Indian. No. 266469(a), U. S. N. M.

Fig. 347
Left femur of Chicama Indian of Peru. No. 2, U. S. N. M.

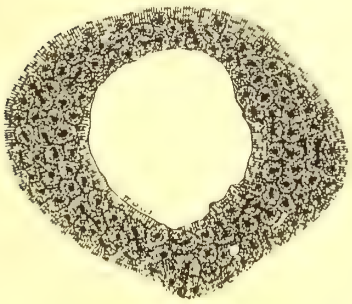

Fig. 348
Right femur of Chicama Indian of Peru. No. 3, U. S. N. M.

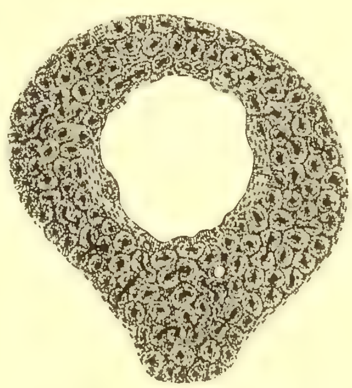

Fig. 349
Right femur of Chicama Indian of Peru. No. 1, U. S. N. M.

Fig. 350
Left femur of Chicama Indian of Peru. No. 4, U. S. N. M.

MAN (YELLOW-BROWN)

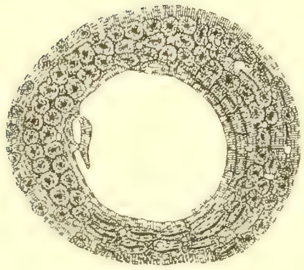

Fig. 351
Left femur of Chicama Indian of Peru. No. 7, U. S. N. M.

Fig. 357
Left femur of Pachacamac Indian of Peru (child). No. 12, U. S. N. M.

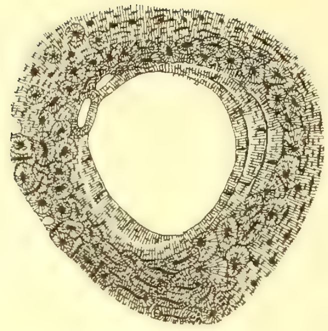

Fig. 360
Right femur of Pachacamac Indian of Peru (adult). No. 15, U. S. N. M.

Fig. 361
Left femur of Pachacamac Indian of Peru. No. 7, U. S. N. M.

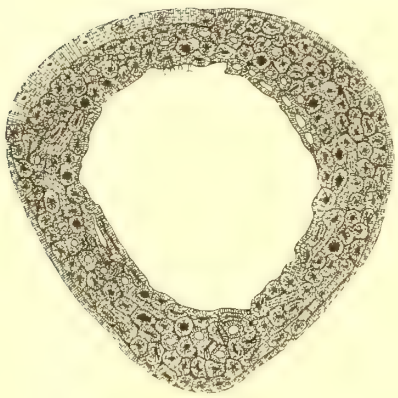

Fig. 362
Right femur of a Japanese male. No. 245, C. M. C.

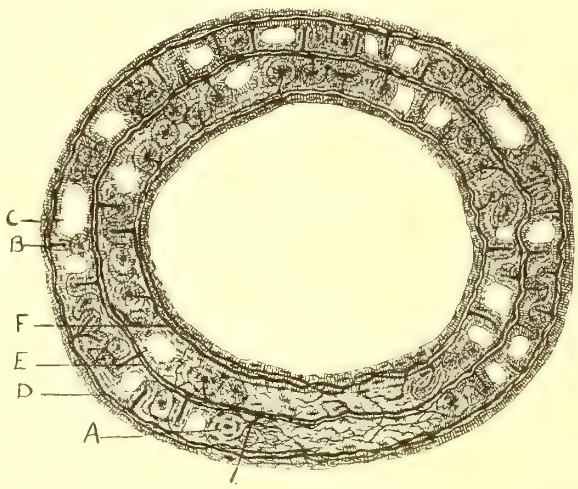

Fig. 363
Femur of Egyptian child of XII Dynasty. No. 256479(de) U. S. N. M.

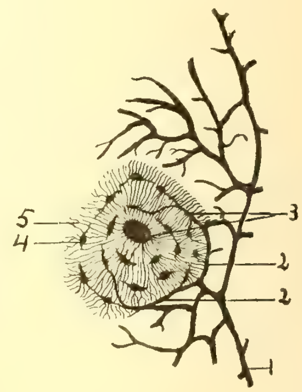

Fig. 363a
Vascular origin of an Haversian system as seen in Fig. 363 at A

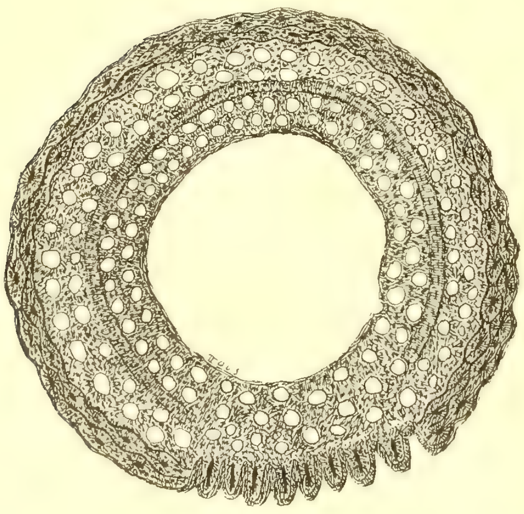

Fig. 364
Femur of Egyptian child of XII Dynasty. No. 256479 (d) U. S. N. M.

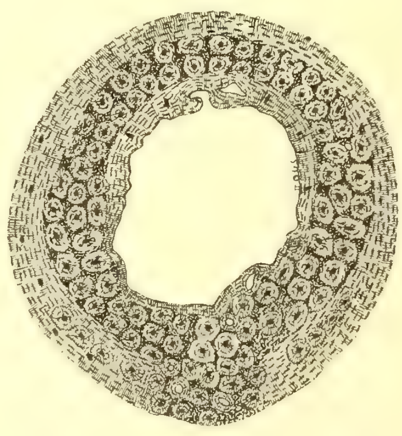

Fig. 365
Right femur of Egyptian child of XII Dynasty. No. 256479(a3), U. S. N. M.

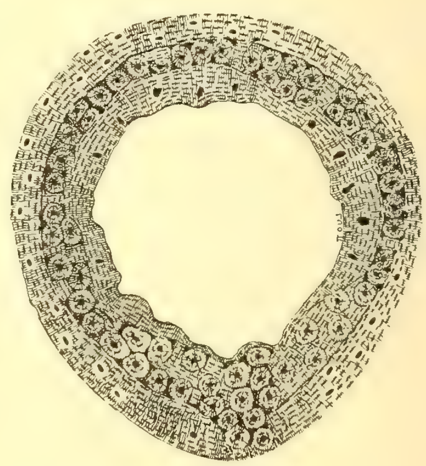

Fig. 366
Femur of Egyptian youth of XII Dynasty. No. 258675(a) U. S. N. M.

MAN (PERUVIAN INDIAN AND EGYPTIAN)

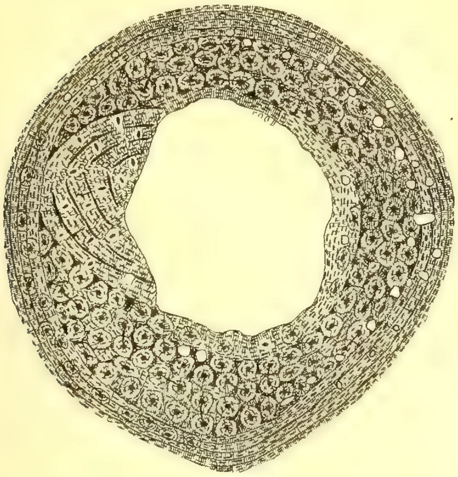

FIG. 367
Right femur of Egyptian adult of XII Dynasty.
No. 256481(d), U. S. N. M.

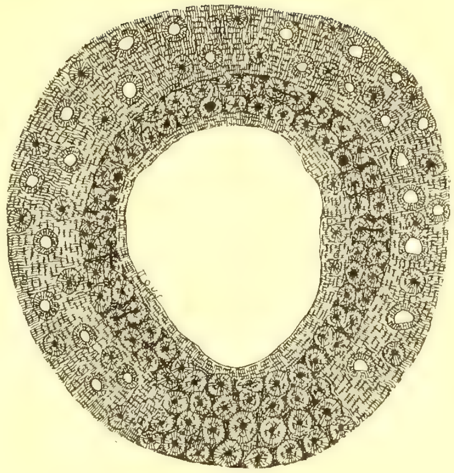

FIG. 368
Left femur of Egyptian adult of XII Dynasty.
No. 256481(a), U. S. N. M.

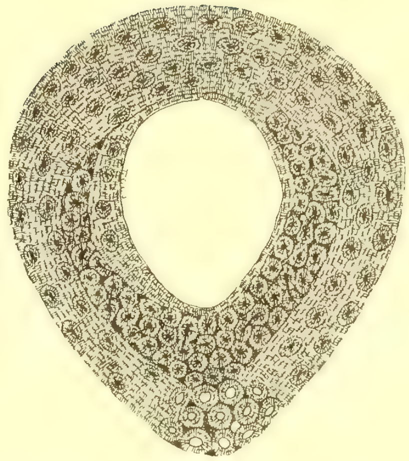

FIG. 369
Right femur of Egyptian adult, XII Dynasty.
No. 258675(e), U. S. N. M.

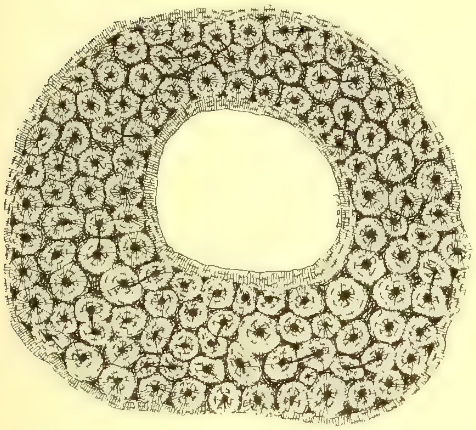

FIG. 370
Femur of Egyptian adult of XII Dynasty.
No. 256478(23), U. S. N. M.

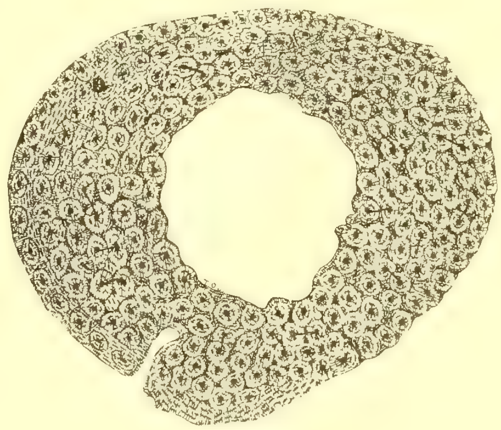

FIG. 371
Right femur of Egyptian adult of XII Dynasty.
No. 256478(x) U. S. N. M.

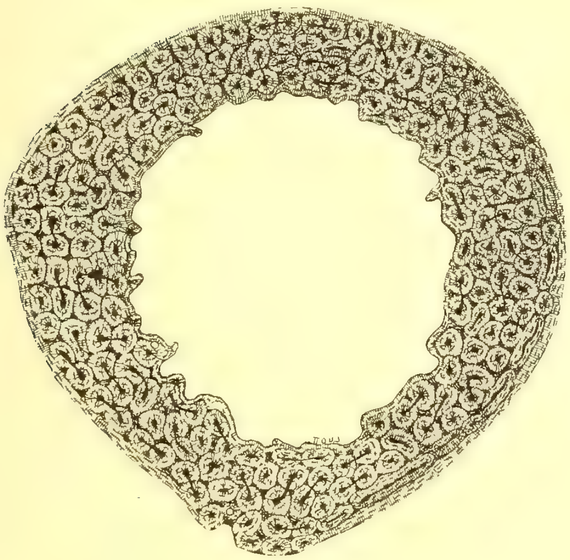

FIG. 372
Femur of a male white. No. 1629, U. S. N. M.

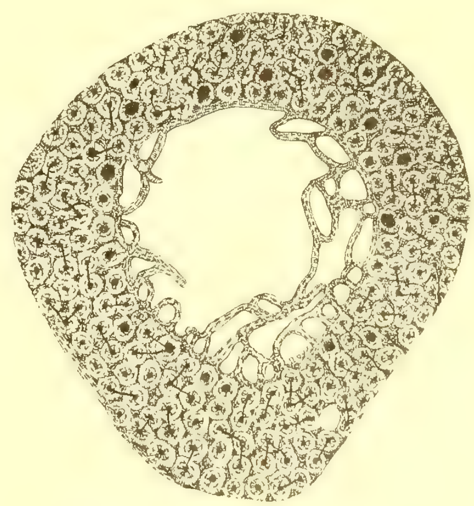

FIG. 373
Right femur of a female white. No. 147, M. D. N. U.

MAN (EGYPTIAN AND WHITE)

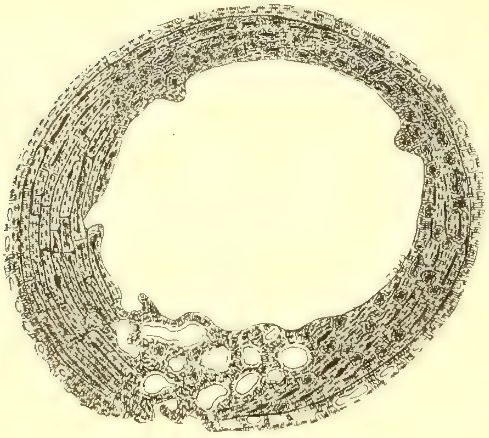

Fig. 374
Right femur of a white child less than one year old. No. 249588, U. S. N. M.

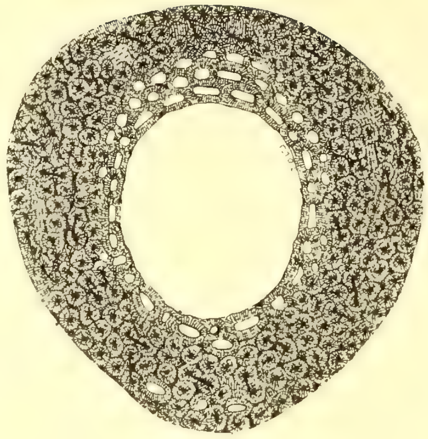

Fig. 375
Femur of a male white. No. 53, C. M. C.

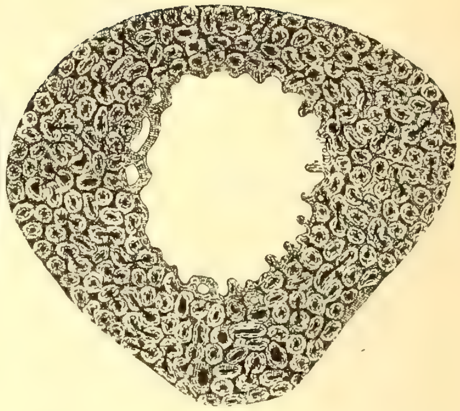

Fig. 376
Right femur of a male white. No. 171, M. D. N. U.

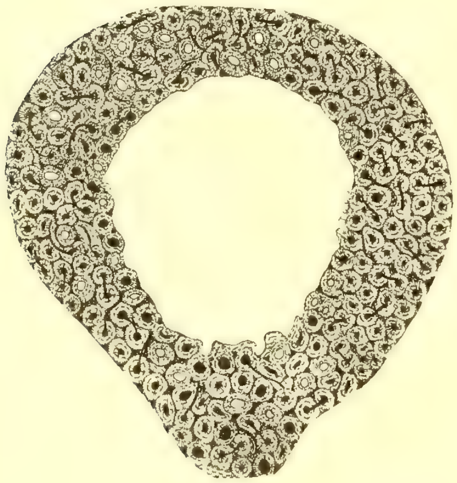

Fig. 377
Left femur of a male white. No. 95, C. M. C.

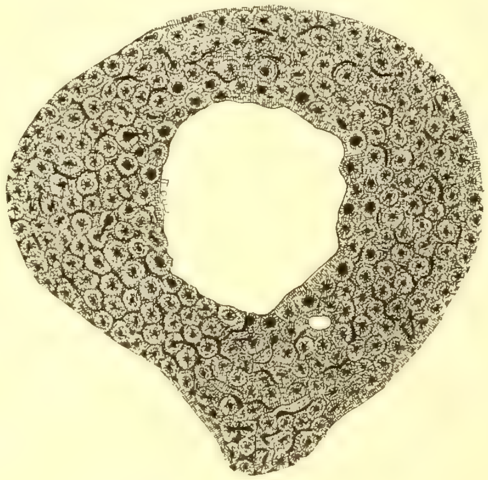

Fig. 378
Left femur of a male white. No. 96, C. M. C.

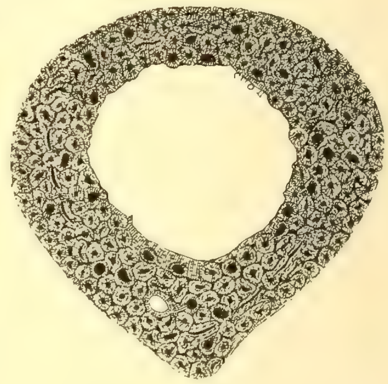

Fig. 379
Left femur of a male white, age 45. No. 168, M. D. N. U.

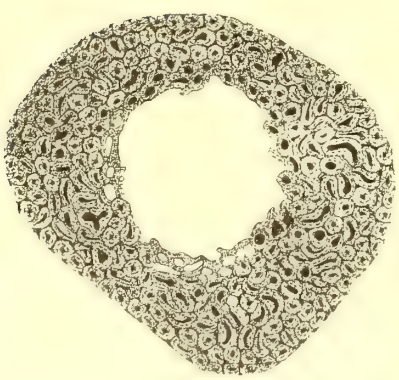

Fig. 380
Left femur of a male white, age 50. No. 10, M. D. N. U.

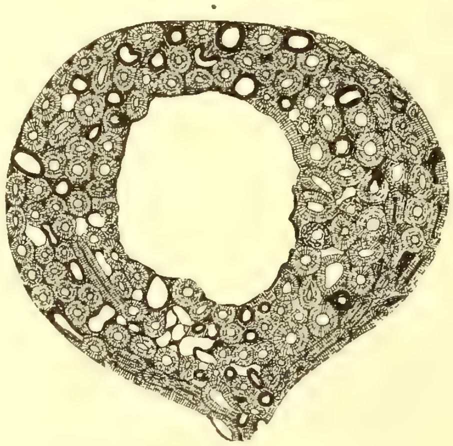

Fig. 381
Femur of a female white, age 52. No. 227876, U. S. N. M.

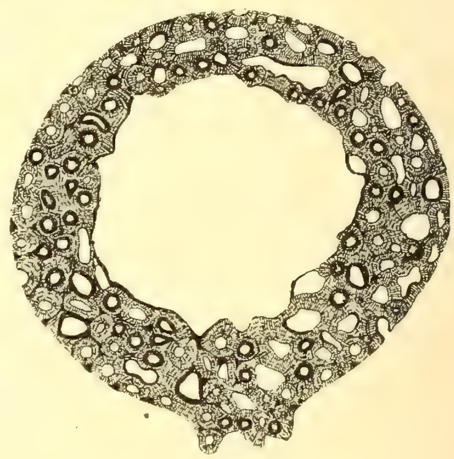

Fig. 382
Femur of a female white, age 60, No. 227880, U. S. N. M.

MAN (WHITE RACE)

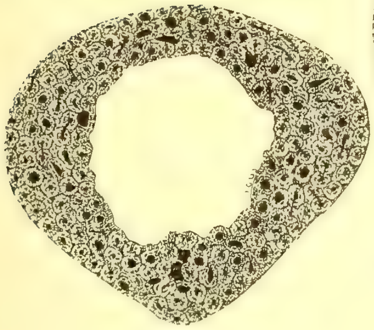

Fig. 384
Left femur of a male white.
No. 162, M. D. N. U.

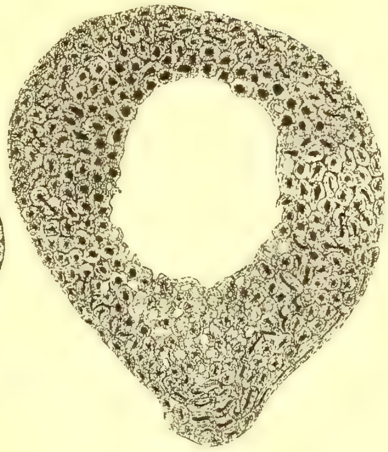

Fig. 385
Right femur of a male white.
No. 244, C. M. C.

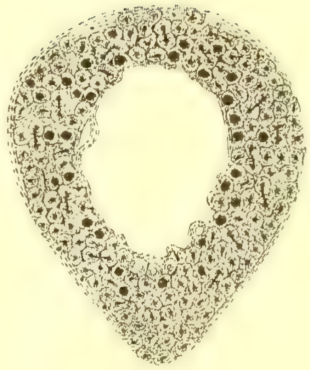

Fig. 386
Right femur of East Indian male.
No. 223, C. M. C.

Fig. 387
Left femur of No. 223 C. M. C.
amputated

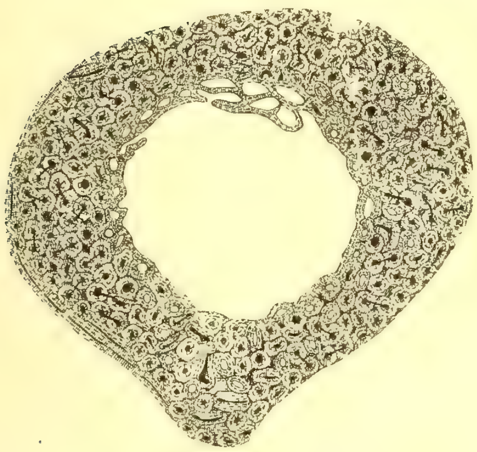

Fig. 388
Right femur of a male white. No. 228479,
U. S. N. M.

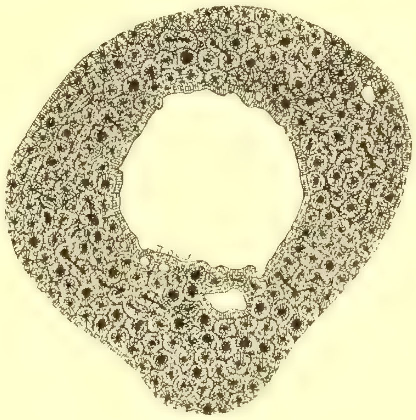

Fig. 389
Right femur of a male white, age 45. No. 154,
M. D. N. U.

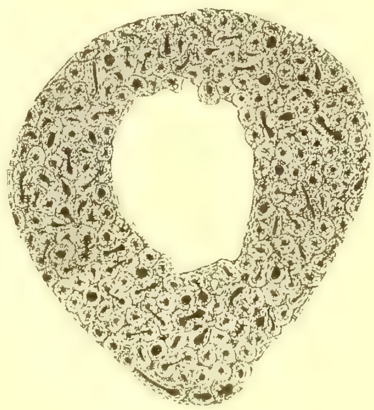

Fig. 390
Left femur of a male white. No. 146,
M. D. N. U.

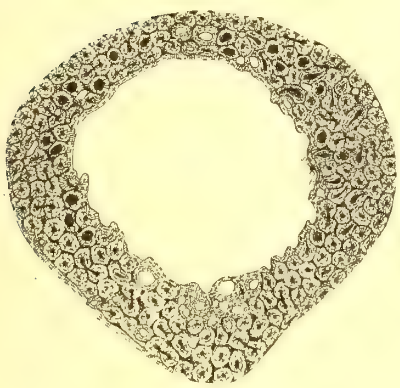

Fig. 391
Left femur of a male white. No. 159,
M. D. N. U.

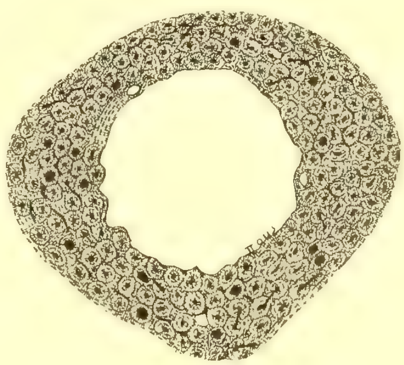

Fig. 392
Right femur of a male white. No. 167,
M. D. N. U.

Fig. 393
Right femur of a male white. No. 172,
M. D. N. U.

MAN (WHITE RACE)

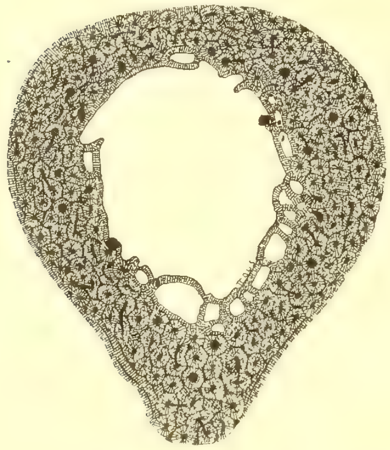

FIG. 394
Right femur of a male white. No. 242,
C. M. C.

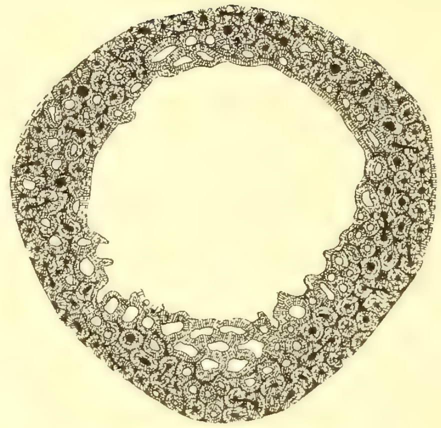

FIG. 395
Right femur of a male white, age 60. No. 145
M. D. N. U.

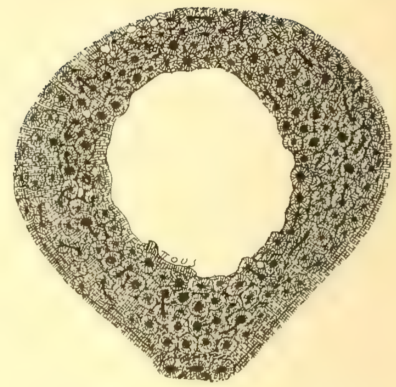

FIG. 396
Left femur of a female white. No. 174,
M. D. N. U.

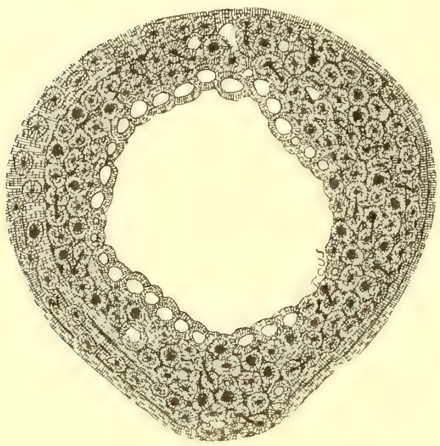

FIG. 397
Right femur of a male white. No. 157,
M. D. N. U.

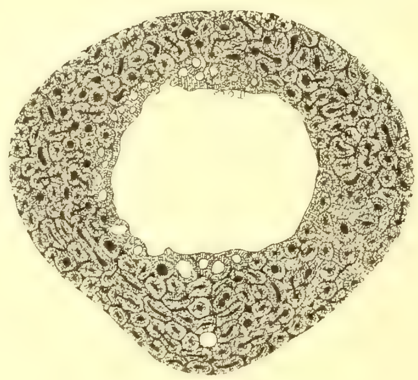

FIG. 398
Left femur of a male white. No. 161,
M. D. N. U.

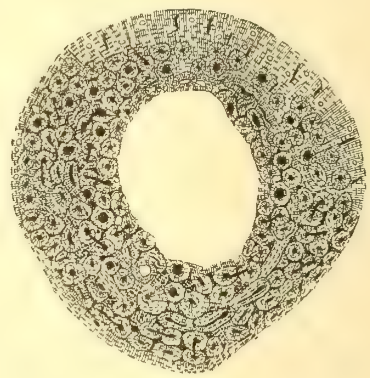

FIG. 399
Right femur of a male white. No. 153,
M. D. N. U.

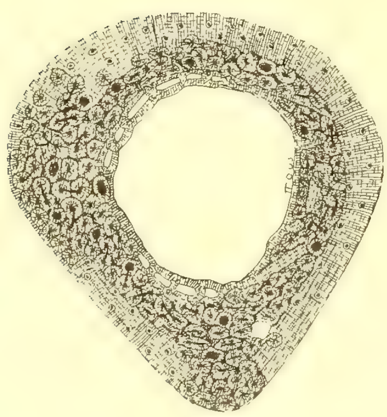

FIG. 400
Right femur of a male white. No. 243,
C. M. C.

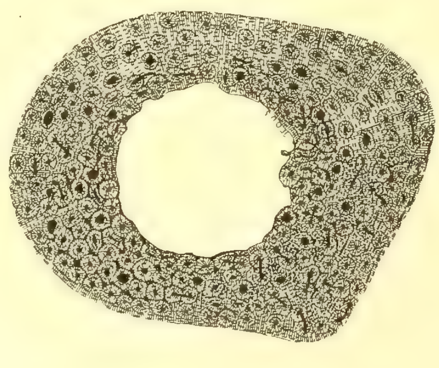

FIG. 401
Left femur of a male white. No. 148,
M. D. N. U.

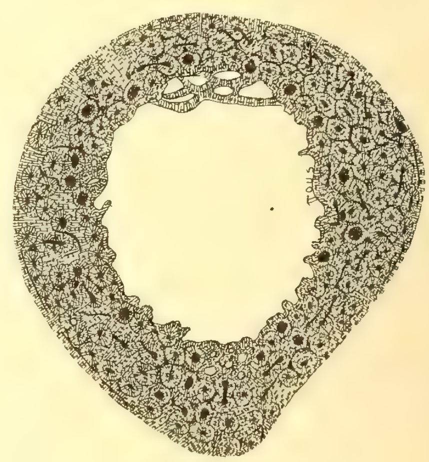

FIG. 402
Left femur of a male white. No. 230,
C. M. C.

MAN (WHITE RACE)

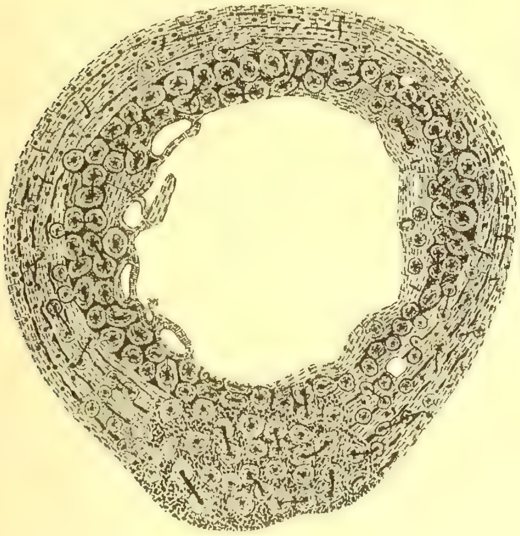
FIG. 403
Left femur of a male white. No. 97, C. M. C.

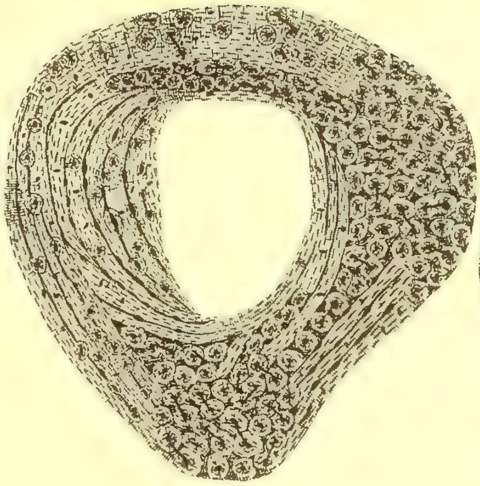
FIG. 404
Left femur of a male white. No. 99, C. M. C.

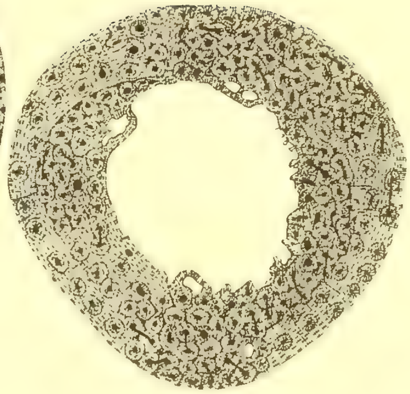
FIG. 405
Right femur of a male white. No. 160, M. D. N. U.

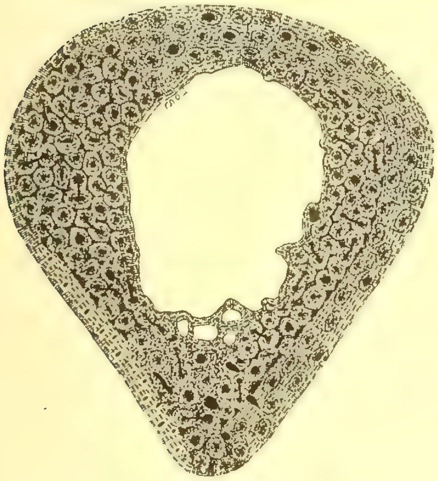
FIG. 406
Left femur of a male white. No. 163, M. D. N. U.

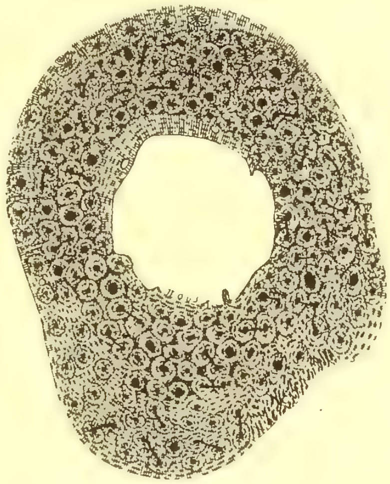
FIG. 407
Right femur of a male white. No. 156, M. D. N. U.

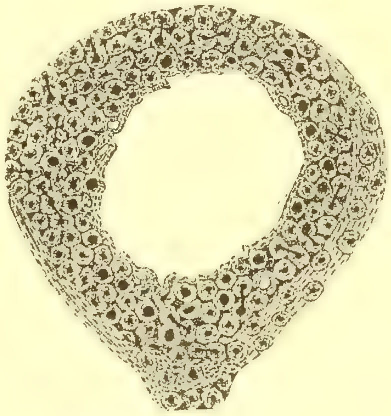
FIG. 408
Left femur of a male white. No. 169, M. D. N. U.

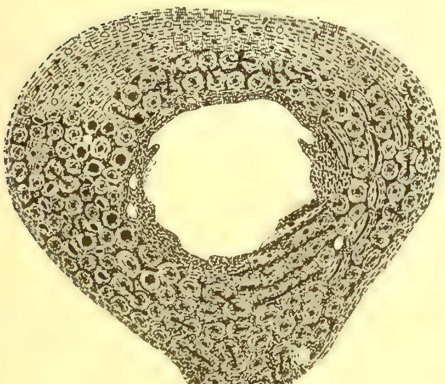
FIG. 409
Right femur of a male white, age 35. No. 151, M. D. N. U.

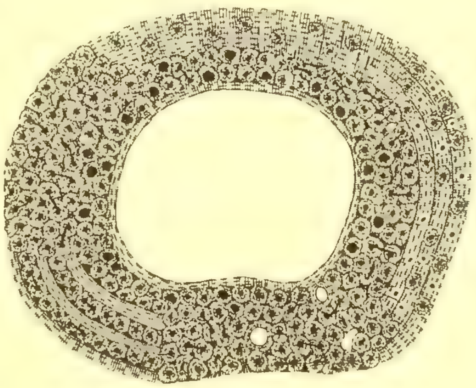
FIG. 410
Left femur of a male white. No. 100, C. M. C.

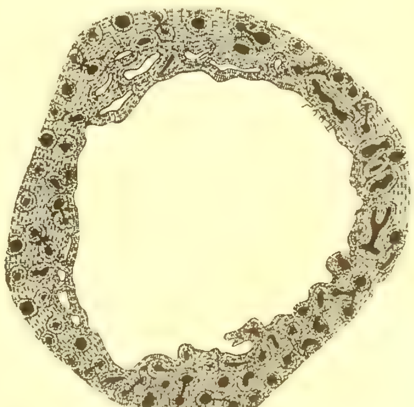
FIG. 411
Right femur of a female white. No. 150 M. D. N. U.

MAN (WHITE RACE)

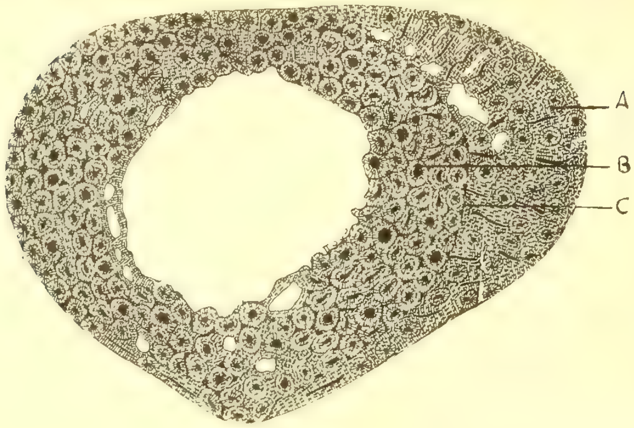

Fig. 412
Left femur of a male white. New bone development seen on the right. No. 152, M. D. N. U.

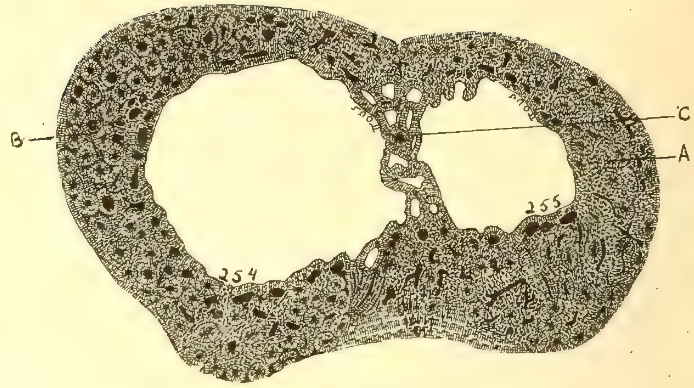

Fig. 413
Left femur, 33 mm. below the section 412. The femur has become double. No. 152, M. D. N. U.

Fig. 414
Left femur of a female white. No. 164, M. D. N. U.

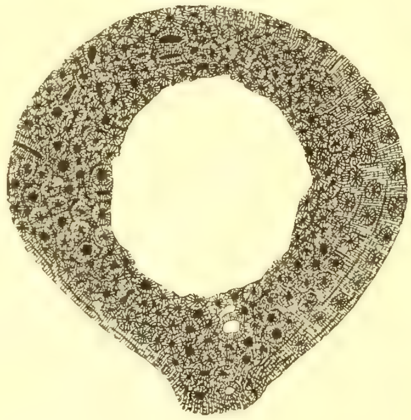

Fig. 415
Left femur of a female white. No. 166, M. D. N. U.

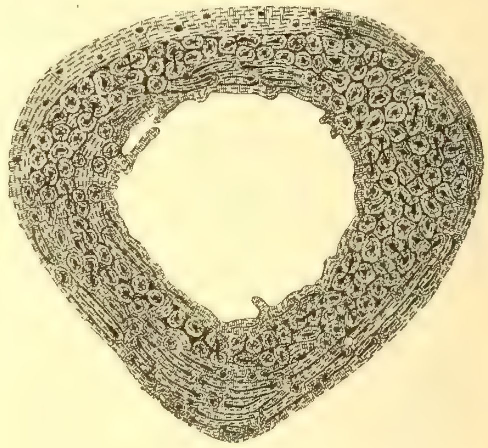

Fig. 416
Right femur of a male white, age 22 (suicide). No. 175 C. M. C.

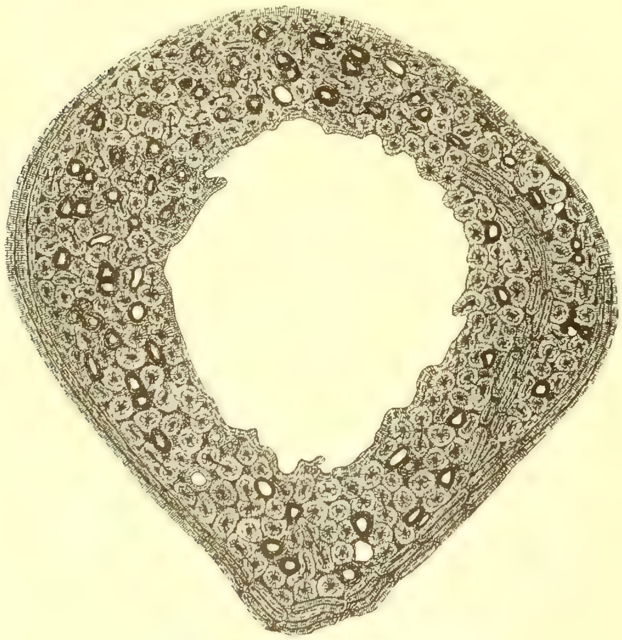

Fig. 417
Left femur of a male white. No. 98, C. M. C.

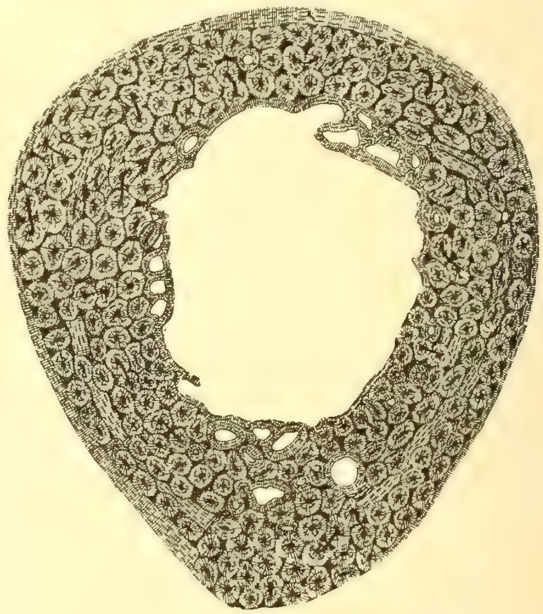

Fig. 418
Left femur of a male white. No. 91, C. M. C.

MAN (WHITE RACE)

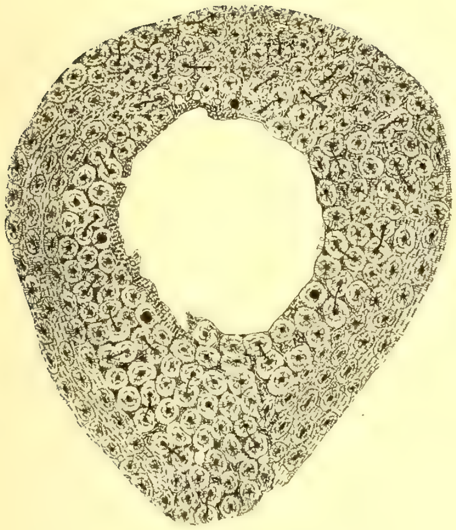

FIG. 419
Femur of an Australian. No. 227420, U. S. N. M.

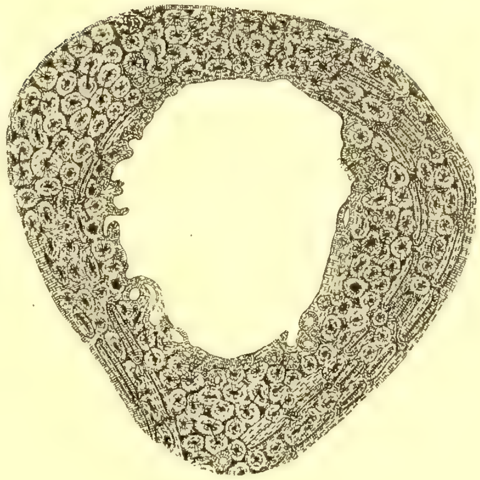

FIG. 420
Left femur of a male white. No. 94, C. M. C.

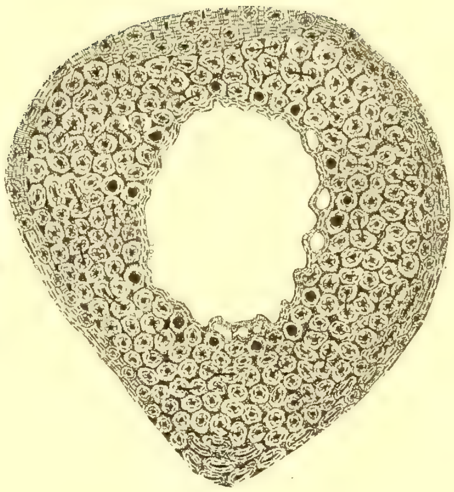

FIG. 421
Right femur of a male white. No. 142, M. D. N. U.

MAN (AUSTRALIAN; WHITE RACE)

FIG. 423
A single Haversian system enlarged showing lamellæ

FIG. 424
Haversian system showing early stage of senility

FIG. 425
Haversian system showing later stage of senility

FIG. 426
Haversian system showing latest stage of senility

DIAGRAMS SHOWING STAGES OF SENILITY

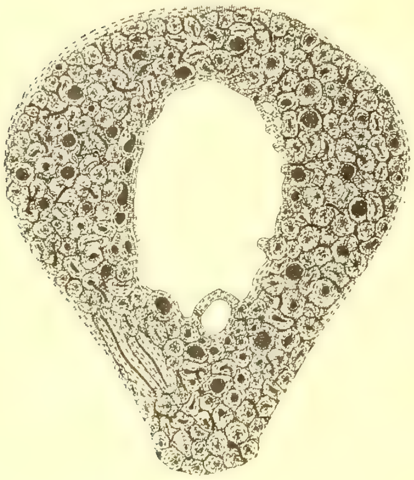

FIG. 428
Right femur of male white (convict). No. 2, M. D. Neb. U.

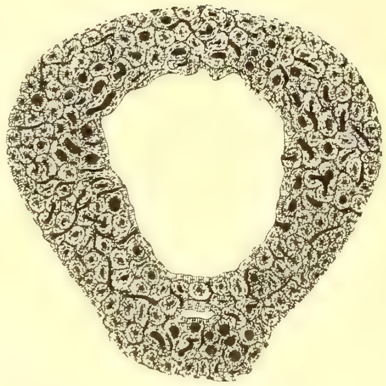

FIG. 429
Right femur of a male white (convict). No. 3, M. D. Neb. U.

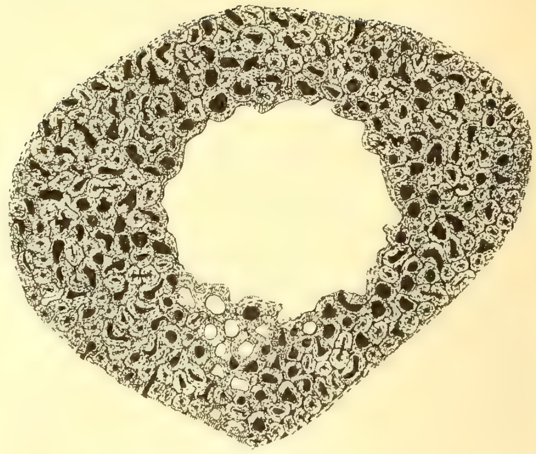

FIG. 436
Right femur of a male white. No. 274, C. M. C.

FIG. 437
Right femur of a male white. No. 275, C. M. C.

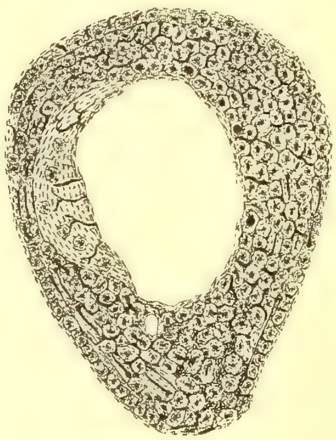

FIG. 439
Right femur of a male white. No. 277, C. M. C.

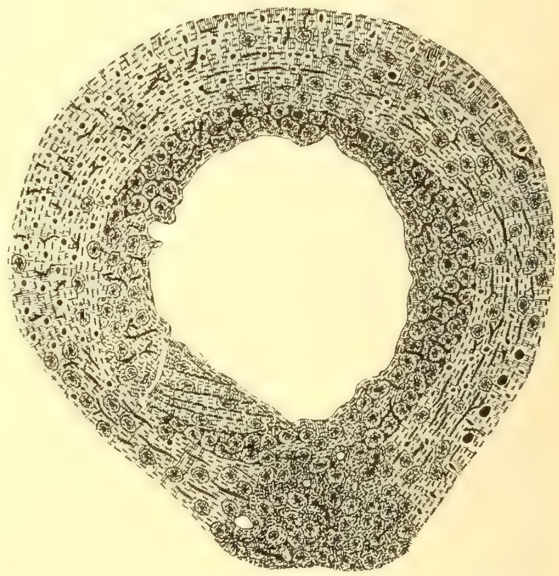

FIG. 445
Right femur of a white male. No. 284, C. M. C.

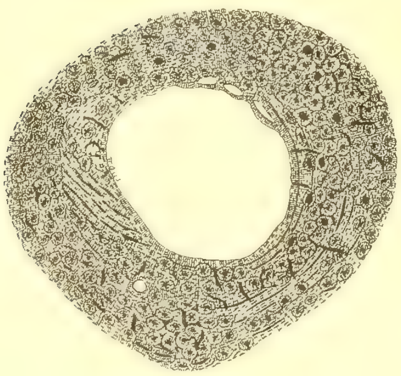

FIG. 451
Right femur of a male white. No. 289, C. M. C.

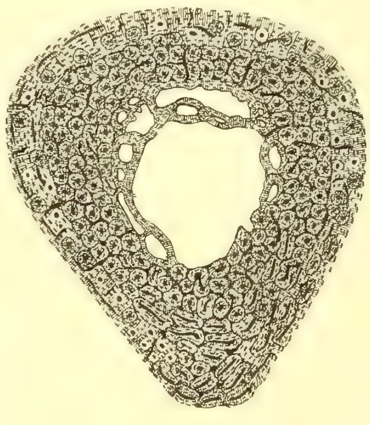

FIG. 452
Left femur of a male white. No. 296, C. M. C.

FIG. 453
Left femur of a male white, age 40 (case of idiopathic epilepsy). No. 1, N. S. H.

MAN (WHITE RACE)